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# BULLETIN

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# SALT AND GYPSUM INDUSTRIES OF NEW YORK

BY

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# PREFACE

The following bulletin on the salt and gypsum industries of New York State is published in accordance with the law of 1892 relating to the appropriation for the geological map. As its preparation has been somewhat hurried in order to ensure its appearance during the legislative session of 1893, it has not attained that fulness of detail, and perfection of literary finish which was originally hoped for by the author. He trusts, however, to be able to remedy any errors or omissions in a subsequent edition which may be prepared more at leisure. The purpose of this bulletin is not merely to publish such new information as can be gathered, but to give in concise form what has previously been made public. Therefore, in order to make the report as reliable as possible, the most authentic sources of information have been drawn upon. In this connection grateful acknowledgments are made to Prof. I. P. Bishop for well records and statistical information and for several photographic views of salt works. Dr F. E. Englehardt has supplied the author with data of varied character and a detailed article illustrated by drawings, on the manufacture of salt in the State of New York. To Prof. James Hall, State Geologist, the writer is indebted for valuable information and advice.

In the field the author's personal observations have been supplemented by those of Messrs William C. Clarke, E. M., and R. D. White, C. E., who, in the course of their duties in collecting material for the World's Columbian Exposition, have obtained measurements of the altitudes of the salt

wells and have accurately located them on the map. The chapter on gypsum is based on the field notes of Mr Clarke.

The writer has also consulted the following works:

Johnston's Encyclopædia, Article Salt, by Chas. A. Goessman; Elemente der Geologie, H. Credner, 6te Auflage; Chemische Technologie, R. von Wagner, 11te Auflage; Geology of the 3rd Dist. of N. Y. State, L. Vanuxem; Geology of the 4th Dist. of N. Y., James Hall.

Prof. I. P. Bishop's article on salt in New York State published in the report of the State Geologist for 1884, has been freely quoted and also the articles of Dr F. E. Englehardt in the Annual Reports of the Superintendent of the Onondaga Salt Reservation.

The brief historic sketch of the discovery of the Onondaga brines by the Jesuit missionaries has been translated from the original *Relations*, and, for the early history of salt manufacture, Clarke's Onondaga has been consulted.

For information collected by the writer and his assistants the former desires to express his thanks to the salt companies and their representatives and to the proprietors of the gypsum quarries, and it is hoped that they will take sufficient interest in the work to notify him of any errors in this bulletin and to supply him with any new information they may possess.

FREDERICK J. H. MERRILL.

# SALT

## ITS DISTRIBUTION AND ORIGIN

Common salt or chloride of sodium in a chemically pure condition consists of chlorine 60.41% and sodium 39.59%. It occurs in great abundance on the earth both in a solid state as halite or rock-salt and in solution in sea water and brine. As rock-salt it occurs in very large masses. It is found interstratified with clay, shale and gypsum in large beds of great extent and its distribution is almost world wide. It occurs in New York, Pennsylvania, Maryland, Virginia, West Virginia, Kentucky, Tennessee, Louisiana, Texas, Ohio, Michigan, Kansas, Utah, Nevada and California, in Canada at Goderich and in South America at the foot of the Peruvian and Bolivian Andes. In Europe it is abundant in the tertiary formations north and south of the Carpathians, and in the Spanish province of Catalonia. In the Triassic formation, important beds of salt occur in England at Cheshire and in Germany in Wurtemburg, Prussia, Saxony and at many other points. It is also found in the Punjaub, in Algeria and in Abyssinia.

The following table of distribution is taken with some modifications from Credner.*

| Geological formation | Locality |
|---|---|
| Recent | Kirghiz steppes; Arabia; South America; shores of Dead Sea and *Great Salt Lake*. |
| Tertiary | Cardona in Catalonia, Spain; Wieliczka and Bochnia in Galicia; Siebenbürgen; Asia Minor and Armenia; Rimini in Italy; *Petit Anse, Louisiana*. |

* Elemente der Geologie 6th Auflage p. 40

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| Geographical formation | | Locality |
|---|---|---|
| Cretaceous | | Westphalia brines, Algiers. |
| Jura | | Rodenburg on the Deister, Bex in Canton of Waadt, Switzerland. |
| Trias | Keuper | Lorraine; Hall, Tyrol; Hallein and Berchtesgaden (near Salzburg). |
| | Muschelkalk | Wurtemburg; in Thuringia, Ernsthall, Stottenrheim. |
| | Buntersandstein | Hanover, Schoeningen near Brunswick, Salzderhelden, Cheshire, England, *Kansas* and *Texas.* |
| Permian | | Gera, Artern (Thuringia) Stassfurt, Halle, Sperenberg; Segeberg (Holstein); Kirghiz steppes on the river Ileck. |
| Carboniferous | | *Kanawha and New river, West Virginia;* Durham, and Bristol, England. |
| Devonian | | *Winchell, Michigan.* |
| Upper Silurian | | *New York, West Virginia, Saginaw, Michigan,* Goderich, Canada. |

The secondary occurrence of crystallized salt must be distinguished from its primary occurrence in beds. Atmospheric waters penetrating into the earth's crust dissolve salt and bring it back to the surface. In this manner salt springs and salt lakes are formed, from which, by evaporation, salt is produced again, and in this connection may be mentioned the occurrence of salt as an efflorescence on the ground in the Kirghiz steppes and in one of the dried up bays of the Caspian sea. Among the well known salt lakes are the Great Salt Lake in Utah, the Dead Sea, that of Eisleben and the Elton Lake near the Volga.

Whatever be the occurrence of salt springs or natural brines it can not be doubted that their contents of salt are derived from the leaching of salt in the solid state. Wherever salt springs abound there is a probability of rock-salt being present in the underlying strata. In addition to the instances mentioned, salt is found dissolved in sea water, and in the polar regions it is found in a granular state on the surface of the ice.

## COMPOSITION OF SEA WATER

Sea water from different parts of the world contains approximately the same substances, as shown by the following analyses*

---

* Wagner; Chemische Technologie, 11th Auflage p. 227.

| | Caspian Sea | Black Sea | Baltic Sea | North Sea Average | Mediterranean Sea | Atlantic Ocean Average | Dead Sea Average |
|---|---|---|---|---|---|---|---|
| Salts in solution | .63 | 1.77 | 1.77 | 3.31 | 3.37 | 3.63 | 22.30 |
| Water | 99.37 | 98.23 | 98.23 | 96.69 | 96.63 | 96.37 | 77.70 |
| | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| The solid matter contains | | | | | | | |
| Sodium Chloride | 58.25 | 79.39 | 84.70 | 78.04 | 77.03 | 77.07 | 36.55 |
| Potassium Chloride | 1.27 | 1.07 | --- | 2.09 | 2.48 | 3.89 | 4.57 |
| Calcium Chloride | --- | --- | --- | .20 | --- | --- | 11.38 |
| Magnesium Chloride | 10. | 7.38 | 9.73 | 8.81 | 8.76 | 7.86 | 45.20 |
| Sodium and Magnesium Bromide | --- | .03 | --- | .28 | .49 | 1.30 | .85 |
| Calcium Sulphate | 7.78 | .60 | .13 | 3.82 | 2.76 | 4.63 | .45 |
| Magnesium Sulphate | 19.68 | 8.32 | 4.96 | 6.58 | 8.34 | 5.29 | --- |
| Calcium & Magnesium Carbonate | 3.02 | 3.21 | .48 | .18 | .10 | --- | --- |
| Nitrogenous & Bituminous matter | --- | --- | --- | --- | --- | --- | 1. |
| | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

The variation in the quantity of these is dependent upon local conditions; upon the character of the sea bottom, upon the dilution of the sea with fresh water near the mouths of large rivers and in the polar regions on the presence of masses of ice; or upon its concentration in land locked bays. The specific gravity of sea water from the open ocean varies between 1.0269 and 1.0289 at a temperature of 17° C. That of the water of the Red Sea is much greater and is about 1.0306.

## DEPOSITION OF SALT BEDS

The theory of the formation of deposits of salt is ably discussed by H. Credner, whom I have freely translated and in part quoted in the following paragraphs.

The beds of rock-salt which occur in the earth's crust have been produced by direct separation from sea water or from the water of inland seas in which chloride of sodium was the principal substance held in solution. In quiet bodies of salt water the stronger brine formed at the surface by evaporation sinks to the bottom and accumulates there, so that a concentration of the salt takes place from the surface toward the bottom.

In open seas full of currents such a concentration cannot occur for, on the one hand, in consequence of the currents, there is a constant mingling of the stronger and weaker

solutions of salt, and, on the other, the rivers replace the evaporated water, but in inland seas, especially those into which but little river water flows, the conditions are the same as in a glass vessel, since in them a saturated solution of salt sinks to the bottom, from which rock-salt crystallizes out and by continual accumulation a layer of salt is formed.

In periods of abundant rainfall when the tributary streams are muddy, beds of saliferous clay are deposited upon the layers of rock-salt. If the mud is calcareous a deposit of carbonate of lime is formed.

On the other hand, in periods of drought when more water evaporates than is contributed by streams, deposits of pure rock-salt are formed; consequently in the course of the year alternate layers of rock-salt and clay are deposited. If the water of a bay, in which such a process of evaporation and deposition is going on, contains sulphate of lime, inasmuch as the saturation of water with sulphate of lime occurs earlier than with chloride of sodium, the former must separate before the separation of the salt begins. This commences when the sea water is concentrated to a saturated solution of salt. Consequently beds of rock-salt very commonly rest upon beds of gypsum or anhydrite, so that layers of gypsum and anhydrite appear between the beds of salt, corresponding to the beginnings of the process of evaporation, interrupted from time to time. Therefore, deposits of gypsum over rock-salt always occur in consequence of a new influx of sea water.

If layers of gypsum and anhydrite occur alone and are not accompanied by layers of rock-salt, either the evaporation has not advanced to the saturation point of the brine or the separated rock-salt has been redissolved by an influx of water. That sulphate of lime separates sometimes free from water as anhydrite and sometimes with water of crystallization as gypsum, may depend upon the amount of the pressure and consequently upon the depth of the enclosing basin for it is estimated that a pressure of ten atmospheres

is sufficient to cause the sulphate of lime to crystallize as anhydrite. This condition would exist at the bottom of a lake 325 feet deep.

Finally, if the waters of the inland sea, upon the bottom of which the deposit of rock-salt is taking place, contain in solution beside chloride of sodium and sulphate of lime other more soluble salts, such as the chlorides of magnesium, potassium and lime, and the sulphates of potash, soda and magnesia, these will be concentrated in the waters diminishing in bulk by evaporation, and by constant separation of the chloride of sodium a mother liquor is formed from which, when the evaporation is complete, they separate as a solid mass and sink to the bottom.

By the drying up of an inland sea, originally containing salts in solution, according to the principles above noted a deposit of gypsum would first separate, then a complex layer of rock-salt with thin layers of clay, marl or gypsum, and finally on the top a layer of the more easily soluble sulphates and haloid salts. These conditions would, however, produce salt deposits of comparatively small thickness since they are limited to the separation of salt from the sea water contained in a basin which is drying up. The existence of deposits of salt, such as those of Stassfurt and Sperenburg in Germany which have a thickness of 1470 and 3600 feet could only be possible in connection with a continual influx of salt water. This might be due to rivers, as in the case of the Dead Sea, or to the cutting off of bays and gulfs of considerable depth by sand bars, over which only as much sea water can enter as is evaporated from the surface. In this way beds of salt may be formed, of which the thickness depends only upon the duration of the conditions which cause the separation of the salt. Such a continuous process of deposition aided by rivers carrying salt in solution goes on in the Dead Sea. The waters of the latter are in the condition of a mother liquor, resulting from a long continued evaporation of salt water. Of

this mother liquor the greater proportion of chloride of magnesium (65% of the salt contents and this 25% of the water) indicates that a great deal of chloride of sodium has already separated from it. Inasmuch as this sea has inlets and no outlets, the water brought in can only escape by evaporation and consequently leaves its salt behind it. The Jordan, the principal river which flows into the Dead Sea, is extraordinarily rich in dissolved constituents, and especially in chloride of sodium and chloride of magnesium of which it contains in 100,000 parts 52 parts of the former and 30 parts of the latter and with which it increases the saline contents of the sea. From this, rock-salt first separates, while chloride of potassium and chloride of magnesium remain behind; but water loses its capacity for dissolving rock-salt in proportion as its contents of chloride of magnesium increase, consequently the deposition of rock-salt goes on continuously as a result of the present composition of the waters of the Dead Sea, for this salt is brought in continuously by the Jordan and the other tributaries, but the amount of chloride of sodium remaining in solution is only from 8.41% to 15.95%. We see consequently in the Dead Sea a continual deposition of rock-salt, caused by the introduction of salt by rivers and the evaporation of water from its surface, and at the same time the presence of a mother liquor which at a depth of 600 feet contains in 1000 parts, 253 parts of dissolved salts consisting of

| | |
|---|---|
| Chloride of Sodium | 25.2 % |
| Chloride of Magnesium | 64.75 |
| Chloride of Potassium | 3.4 |
| Chloride of Lime | 4.3 |
| Bromide of Magnesium | 2. |
| Sulphate of Lime | .3 |
| | 99.95 |

From the final drying up of this liquor by a possible cutting off of all tributary streams a deposit of salt would result consisting essentially of chloride of magnesium and,

in addition, of chloride of sodium, chloride of lime, chloride of potassium and bromide of magnesium. Similar conditions exist in lakes Elton and Bogdo which lie between the Volga and Ural rivers in a broad steppe in which there is a rock-salt deposit. From this a number of streams carrying salt flow into these lakes. As they have no outlet and the water which comes in is removed by evaporation the salt separates upon the bottom and borders of the lakes in solid beds. The streams bring into the lakes chloride of potassium, and sulphate of magnesium, beside chloride of sodium, as well as mud in the spring time. The latter forms thin layers between the strata of salt, while the more easily soluble salts have enriched the lake water to a concentrated mother liquor, which in the Elton lake contains

| | |
|---|---|
| Sulphate of Magnesium. | 5.32 |
| Chloride of Sodium | 3.83 |
| Chloride of Potassium | .23 |
| Chloride of Magnesium | 19.75 |
| Water | 70.87 |
| | 100.00 |

The Great Salt Lake in Utah is also a saturated brine depositing salt, as proved by the incrustations of salt about its margin in dry seasons.

As an example of the continuous deposit of salt in a basin where evaporation and separation of salt is continually replaced by an influx of sea water over or through a sand bar; we may mention the Adschi-Darga bay of the Caspian Sea, of which the bottom is covered with a continually thickening deposit of salt and gypsum.

The formation of salt beds in the geological past must have occurred in a precisely similar manner and consequently they represent former inland seas, or bays cut off from the ocean by the upheaval of sand bars and of which the fluviatile or marine influx contained salt in solution, but yet was not greater in quantity than the amount of the evaporation from the basin. From this it is evident that the con-

ditions for the formation of rock-salt were always present when seas and continents existed. In fact rock-salt occurs throughout the whole list of geological formations as shown in the preceding list of localities. A very instructive example of a salt deposit formed in the manner above described, and chemically, the most complete in the world, is that of Stassfurt in Germany. This interesting deposit is in the Permian formation and its thickness has been ascertained to be at least 2700 feet. Its lower principal mass consists of rock-salt which is divided by thin parallel layers of anhydrite into beds from 2 to 5 inches in thickness. Upon it rests a stratum, 200 feet thick, of impure rock-salt mingled with easily soluble compounds such as chloride of magnesium which is divided by thin layers of polyhalite. Upon this is a stratum 180 feet thick in which rock-salt and sulphates, principally Kieserite (sulphate of magnesia), occur in alternate layers, some of which are a foot thick. The uppermost bed, about 135 feet thick, is composed of a succession of reddish layers of rock-salt and salts of magnesia and potassium (Kainite, Kieserite, Carnallite and Tachyhydrite) in addition to which are also masses of snow white Boracite. The boundaries between these four principal divisions are not exact, and the change from one to the other is gradual. This deposit is of wide extent.

## SALT IN NEW YORK STATE

As the presence of salt in New York was first made manifest through saline springs it is proper to begin this discussion with the history of their discovery and utilization.

The most important of these are in Onondaga Co. at Syracuse.

About the middle of the seventeenth century several of the Jesuit missionaries during their journeys among the Indians, in what is now the State of New York, heard of certain springs which were regarded with superstition and said to be possessed of demons. Upon investigation these

were found to be salines and the Indians were shown that the demons could be exorcised by means of fire. In the "*Relations*" of the Jesuit fathers we find the earliest records of these salt springs.

Father Jerome Lallemant says in his *relation* 1646: "The fountain from which very good salt is made, springs up in a beautiful plain surrounded by a fine wood. At eighty or a hundred paces from this salt spring is another one of fresh water, and these two take their birth from the bosom of the same hill."

Charlevoix says (1646): "The Canton of Onondaga has a very beautiful lake called Ganentaha around which are several salt springs and of which the borders are always covered with very fine salt."

Creuxius says (1655) speaking of the shores of Lake Ganentaha: "The meadow is intersected by two fountains situated about a hundred paces from one another: of the one the salt water furnishes an abundance of the best salt; the pure water of the other is good to drink, and what is remarkable, is that both spring from one and the same hill."

Father Simon Le Moyne says in his *relation* of the return voyage from the Iroquois nations August, 1664: "We arrived at the inlet of a small lake, in a great basin half dry. We tasted the water of a spring which they (the Indians) dared not drink, saying that there was in it a demon which rendered it fetid, and having tasted it I found that it was a fountain of salt water; and in fact we made from it salt as natural as that from the sea, of which we carried a specimen to Quebec."

This discovery of salt by the Jesuits led to its manufacture by Indians and traders. In 1770 salt was in common use among the Delaware Indians. The traders were, at that time, in the habit of bringing it to Albany along with their furs.

## DEVELOPMENT OF THE ONONDAGA SALT FIELD

The systematic manufacture of salt in the vicinity of Syracuse by white men was begun in 1788. In a letter from Colonel Comfort Tyler to Dr Jeremiah Van Rensselaer* he says that in May, 1788, his family needed some salt and he obtained about a pound from the Indians which they had made from the springs near the shore of the lake. The Indians offered to show him the location of the brine springs and accordingly he went to the lake with a guide. The guide in his canoe took Col. Comfort out of the mouth of Onondaga Creek easterly into a pass since called Mud Creek. After passing over the marsh then covered by about 3 feet of water and starting toward the bluff upon which was afterward founded the village of Salina, he fastened his canoe and pointed to a hole in the ground which had apparently been dug there and said that there was the salt. In the same year Asa Danforth and Col. Tyler undertook the manufacture of salt in a very primitive way, their only outfit being a 5-pail kettle suspended by a chain from a pole resting upon two crotched stakes.

In 1789 Nathaniel Loomis started a small establishment with a number of kettles and during the winter of 1789–90 made from 500 to 600 bushels of salt which he sold for $1 a bushel.

William Van Vleck made salt at Salt Point and Jeremiah Gould afterwards made salt in kettles on arches.

In 1793 Moses Dewitt and William Van Vleck entered into partnership, erected an arch containing 4 potash kettles and manufactured salt enough for the wants of the inhabitants of the neighboring country. In the same year James Geddes began manufacturing salt at the place which now bears his name, and shortly after John Danforth begun to make salt at Liverpool.

In 1797 the legislature of the State of New York passed

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* Essay on Salt.

the first laws relating to the manufacture of salt at the Onondaga salt springs and William Stephens was appointed superintendent. Details of this act may be found in the laws of that year.

In 1798 an association called the Federal Company was organized. It erected the largest plant known at that period, consisting of 32 kettles which were set in blocks of 4 each. The brine was pumped by hand from the shallow wells, less than 30 feet deep, into reservoirs made of hollow logs. The first well of any large size was sunk under the direction of William Kirkpatrick who was appointed superintendent in 1806. This well was at Salina. It was 20 feet square and 30 feet deep. Each manufacturer had his own pump which was worked by hand and the brine was carried in conduits to the different works.

In 1810 under Sup't John Richardson, the water of Yellow Brook was conducted from Syracuse to Salina in order to drive a wheel for pumping the brine. Shortly afterward the pumps were worked by horse-power.

In 1820 the legislature authorized Benajah Byington to bore for rock-salt on the reservation, offering a premium for any salt produced. His explorations were chiefly made on the high grounds east of Salina and were entirely unsuccessful. In 1838 an appropriation was made to enable the superintendent to sink a shaft or well 600 feet deep. A well was sunk to this depth but without finding any rock salt.

The further history of the Onondaga Salt Reservation may be found in detail in the works quoted in the preface.

The brine springs of Montezuma in Cayuga Co. were only second in importance to those of Onondaga Co. and for a time were utilized in the manufacture of salt. In 1823 the salt made there amounted to between 16,000 and 20,000 bushels.

The following additional list of brine springs is taken from the report of Lewis C. Beck on the mineralogy of

New York 1842. As the matter has not since been investigated no later record is accessible.

Up to the date of that report no salt springs had been found east of Saltspringville, about 14 miles from Cooperstown near the line between Otsego and Fulton Counties. These springs were very weak in brine containing only 3% or 4 %, but were of sufficient importance to furnish salt to the people residing in that region.

In 1833 a brine spring was discovered in Delaware Co. on Elk brook, about 4 miles from Delhi. In Oneida Co. salt springs occur near Vernon Centre and again near Oneida. According to Eaton these are the first brine springs in the Salina group. Brine has also been found at Lenox in Madison Co. At the Triangle in Broome Co. salt water occurs which yields salt of great purity, and brine is also said to exist in the County of Cortland. In Oswego Co. are several weak brine springs. One of these is in a marsh two miles square in the town of Hastings. Two miles west of this is another spring. At Central Square is still another. There are other salines in the towns of Constantia, Richland and Hannibal. From the eastern part of Oswego Co. to the Niagara River numerous brines are found in the red sandstone.

In Wayne Co. are several salines. They are at Galen in the town of Savannah on the western edge of the Cayuga marshes. This brine contains somewhat less than 9% of salt. There is also a spring about 2 miles from Lockville. Another brine spring is near the head of Little Sodus Bay. Weak brine has been reported from the village of Clyde. A few salines, not of economic importance, are found in Monroe Co. One of these is on Irondequoit Bay 2 or 3 miles from Lake Ontario. Salt was at one time manufactured from this brine. Another spring, also somewhat worked formerly, is in the town of Greece 2 miles north of the ridge road and 9 miles west of the City of Rochester. To these may be added the 3 springs on the

banks of the Salmon creek near Clarkston 2 miles north of Ladd's Corners. Salt springs are moreover of frequent occurrence along almost all creeks and small streams, and salt was formerly manufactured from some of them in small quantities.

In 1834 brine was found in Livingston Co. $2\frac{1}{2}$ miles southwest of York. This supply after a time, ceased to flow. Salt water was found by boring, in the town of Elba 8 miles northwest of Batavia. A number of brine springs have been observed in Orleans Co. In Carlton, at Kendall and at Holley, salt has been manufactured from saline springs. At Oak Orchard also, salt has been made from the natural brine. In Niagara Co. several brine springs occur on Eighteen-Mile creek between Lockport and Lake Ontario.

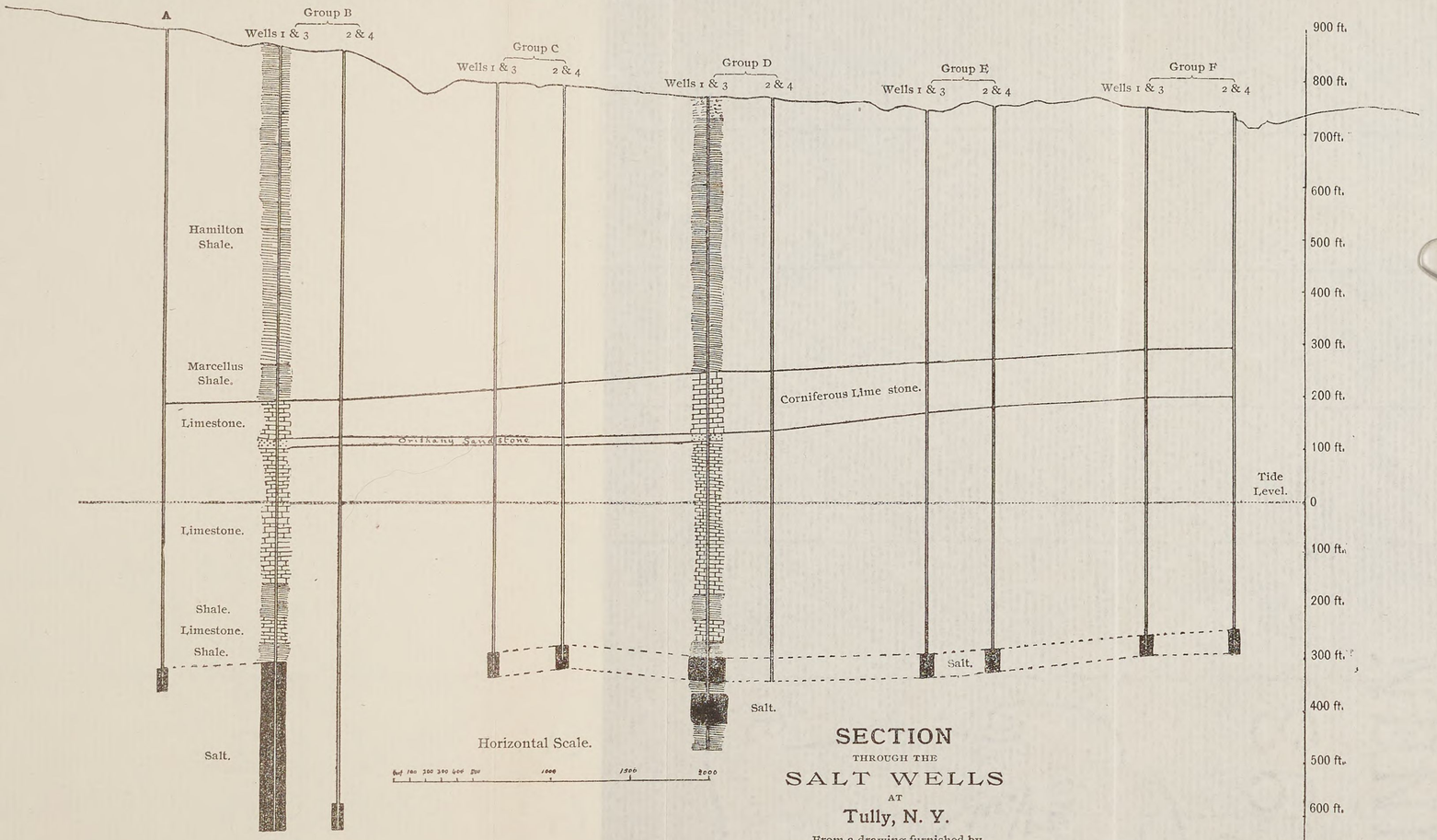
## DISCOVERY OF ROCK SALT

It had been recognized by the New York geologists that the Onondaga salt springs must be supplied from the leaching of beds of rock-salt, and for a time efforts were made to find it in the immediate vicinity of Onondaga Lake. The various borings made on the reservation however showed conclusively that no salt was there. With a more careful study of the rocks of the Salina group it became manifest that those enclosing the gravel-filled basin from which the salt springs flowed were not the ones in which salt could be expected, and the conclusion was drawn that the brine came from the south through an old river channel now filled with gravel and sand and into which flowed the salt water produced by the leaching of beds of salt interstratified with the salina shales. It remained for the existence of rock-salt thus inferred in this geological horizon to be demonstrated accidentally in the boring of an oil well in Western New York. The history of the discovery and development of the salt beds of western New York has been discussed at length by Mr I. P. Bishop.*

* Report of the State Geologist for 1884.

In 1878 salt was found at a depth of 1279 feet in a well bored for oil in the village of Wyoming, Wyoming county. This well was one of a number bored by order of the Vacuum Oil Co. of Rochester at various points in the western part of the state. In this boring a bed of salt 70 feet thick was found. As a result of the discovery of salt at Wyoming a well was bored at LeRoy under a contract between the citizens of that place and the Vacuum Oil Co. by the terms of which the expense was borne by joint subscription. This well was started in December 1878 and no considerable mass of rock-salt was found, but in March 1879, at a depth of 610 feet a copious supply of brine entered the bore.

In August 1881 a company was organized at Warsaw for the purpose of investigating the deposits underlying that place, and in October salt was found at a depth of 1620 feet in a well bored near the Buffalo, Rochester and Pittsburg R. R. The stratum of salt here proved to be 80 feet in thickness. In 1882 another company, the Crystal Salt Co. of Warsaw, sank a well at the locality now known as Saltvale. Here a satisfactory deposit of salt was also found. In 1883 a well was bored by Dr W. C. Gouinlock near the Buffalo, Rochester and Pittsburg R. R. station. There salt was found on May 5 at a depth of 1640 feet, and on the same day it was reached in the Stedman, Humphrey and Webster well near the Erie station. Following these pioneer explorations a number of companies sank wells and began operations in making salt. The Empire and Hawley Companies located near the Erie R. R. track south of Warsaw, and at Wyoming and Castile salt factories were established during the same year. Works of considerable capacity were also erected at Silver Springs and began operation in January 1885. Other wells were sunk near the Erie R. R. at Warsaw and the Eldridge well between Warsaw and Rock Glen was bored. Alexander Kerr Bros. & Co. of Philadelphia bored a well at Rock Glen. In 1883 salt was




# SECTION
THROUGH THE
# SALT WELLS
AT
## Tully, N. Y.

From a drawing furnished by
THE SOLVAY PROCESS CO.

found in the Genesee valley. In the vicinity of Greigsville a series of test wells were sunk under the direction of Mr C. Q. Freeman, and in September 1884, a shaft was begun in that locality. In September 1885, salt was reached at a depth of 995 feet. This deposit is now operated by the Retsof Salt Mining Co. Near the Genesee river salt works were erected at Piffard by the Livingston Salt Co. and about two miles south of Mt Morris by the Lackawanna Co. At Piffard also, works were established by the Genesee Salt Co. In 1885 works were completed at Lakeville. In 1886 salt factories were completed at York and others were erected at Cuylerville.

At Pavilion a well was bored reaching a salt bed 64 feet thick. At Pearl Creek station a factory was established with two wells. About two miles south of Le Roy station the Lehigh Salt Mining Co. has sunk a shaft reaching salt at a depth of 765 feet, and is now sinking a second shaft in compliance with the law. At Livonia and Greigsville other shafts have been sunk.

To enumerate further, the various wells and their history is unnecessary to the purpose of the present report. The growth and development of this industry is best shown by a complete list of producers at the end of this report.

As shown on the accompanying map explorations for salt have been made at many points outside of the Oatka Genesee district.

The locality which is of most interest to the geologist on account of the completeness of the records kept and the large number of wells bored is Tully in Onondaga Co. Through the courtesy of Mr Wm. B. Cogswell, I am enabled to publish a section of the strata penetrated by the thirty wells bored by the Solvay Process Co. at this point. These borings are of especial interest because they confirm the conclusions of Prof. Jas. Hall regarding the presence of rock salt south of Syracuse.

## GEOLOGY OF THE SALT AND GYPSUM

The salt of New York occurs almost exclusively in the Salina Group or as it is also called the Onondaga Salt Group of the Upper Silurian Period which was described by Vanuxem as follows:*

"This important group contains all the gypsum masses of western New York, and furnishes all the salt water of the salines of the counties of Onondaga and Cayuga. From the point where the Niagara group terminates at the east, it rests upon the Clinton group; and as the latter group also comes to its end near the first district, it reposes there upon the Frankfort slate, upon which it continues to near the Hudson river.

It forms a part of the high range on the south side of the Mohawk; appearing at the north end of Otsego county, and in Herkimer and Oneida, being its northern outcrop. It makes its first appearance by the side of the Erie canal at the east end of Madison county, and from thence west the canal was excavated in the group.

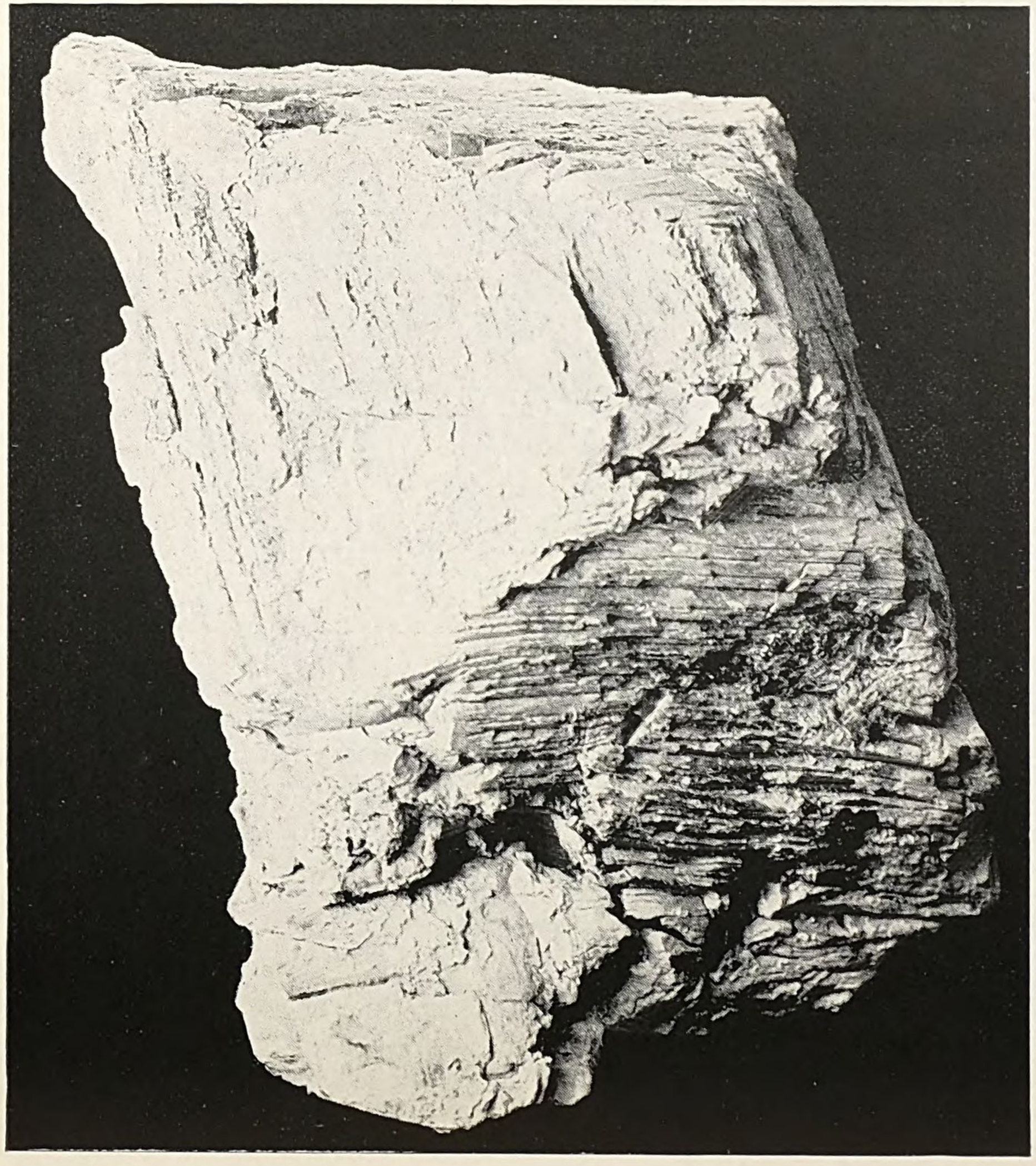
The Onondaga salt group may be divided into four deposits. There are no well defined lines of division between the deposits; but for practical purposes the divisions are sufficiently obvious.

The first or lowest deposit is the red shale, showing green spots at the upper part of the mass. 2d, The lower gypseous shales, the lower part alternating with the red shale, which ceases with this mass. 3d, The gypseous deposit, which embraces the great masses quarried for plaster, consisting of two ranges, between which are the hopper-shaped cavities, the vermicular limerock of Eaton, and other porous rocks. 4th and lastly, Those rocks which show groups of needle-form cavities placed side by side, caused by the crystallization of sulphate of magnesia,† and which may from that circumstance be called the magnesian deposit.

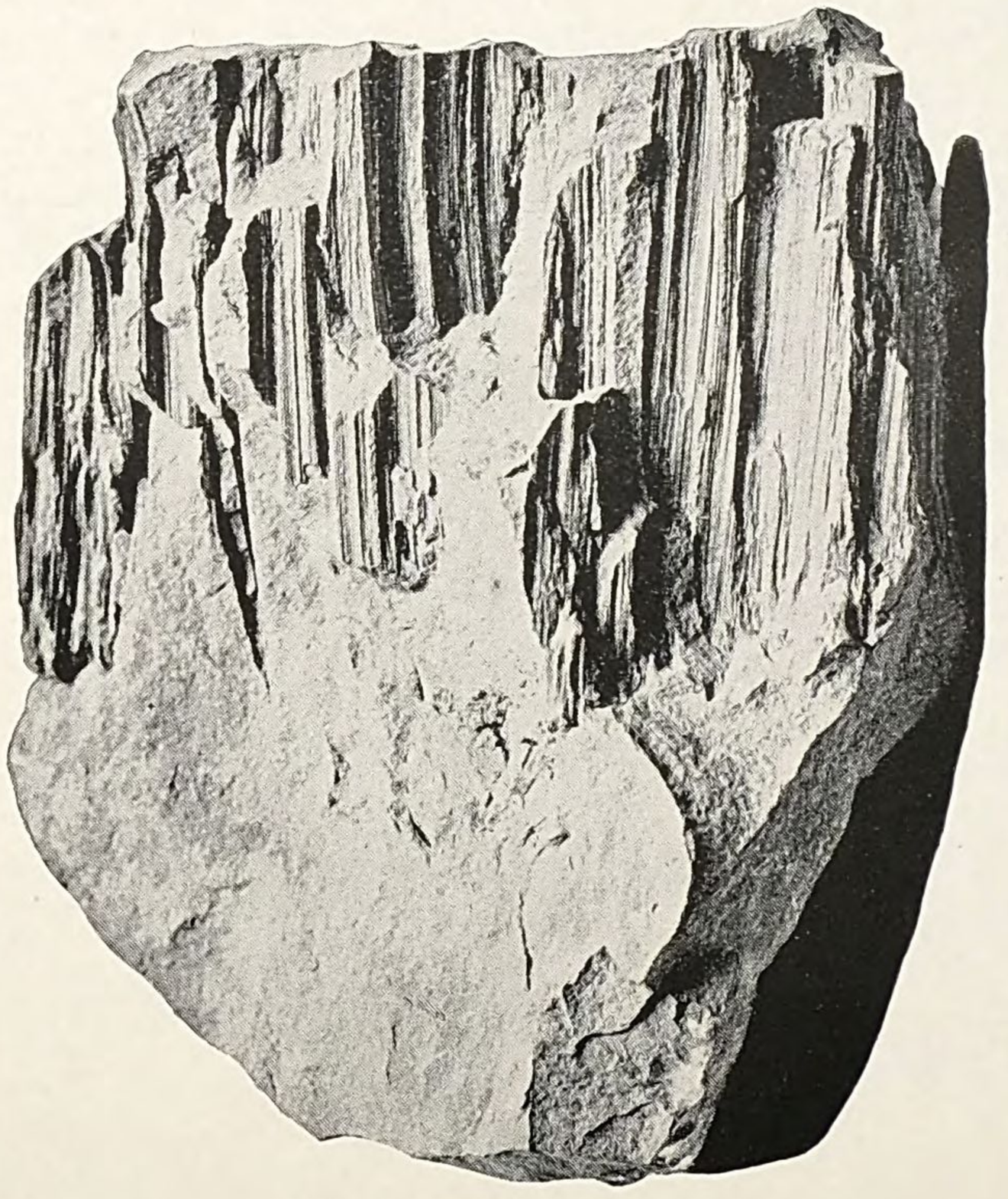
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* Report on the Geology of the 3rd District of N. Y.

† Sulphate of lime most probably.



MUD CAST OF HOPPER-SHAPED CRYSTAL. X½



NEEDLE-LIKE CAVITIES.

The whole of these deposits are found between Oneida creek and Cayuga lake. To the east of the creek, they do not all occur, as will subsequently be made known. They thin out to the eastward and probably terminate entirely a few miles east of the Hudson river; from which point their thickness gradually increases towards the west, and reaches its maximum in the counties of Onondaga and Cayuga, where it is not less than seven hundred feet. The gypsum has not been seen east of the western part of Oneida county. The red shale comes to its end at the east end of Herkimer county; and the whole group is reduced, in the Helderberg in Albany county to a few feet of light grey or lavender-colored compact calcareous rock with pyrites, separating the Frankfort portion of the Hudson river group from the water-lime series."

The outcrop of the Salina shales as shown on the accompanying map is copied from the geological map of New York published in 1844.

The red shale is fine grained, earthy in fracture and without regular lines of division. It breaks or crumbles into irregular fragments. This deposit is not found east of Herkimer County and varies in thickness from 100 to nearly 500 feet. The second member of the series consists of shale and calcareous rock of a light green color intermingled with a red shale at its lower part. But little gypsum occurs in this member. The rock is extremely porous, easily penetrated by water and falls to pieces at once on exposure to the air. The third or gypseous deposit, which is important commercially on account of its plaster beds, is also the horizon from which the brine springs of Onondaga, Cayuga and Madison counties were supposed by Vanuxem to have been derived. The mass of the deposit consists of rather soft yellowish or brownish shale and slate, both argillaceous and calcareous. It may be called a gypseous marl. It falls to pieces when exposed to the weather, breaking in a series of joints nearly at right angles to each other which give the

rock a rhombic cleavage. In the third district the gypsum of this horizon does not often occur in layers or veins, it usually occurs in isolated masses of irregular form. At many points there appear to be two ranges or levels of these plaster beds as they are called, separated by shale containing hopper-shaped cavities. These cavities are of much interest for they represent the external casts of salt crystals which were probably formed during the evaporation of the water from the basin in which the Salina deposits were laid down. These cavities are from one to ten inches in diameter. But few fossils are found in the Salina group, for at the time when the shale and gypsum were deposited the water contained too high a percentage of soluble salts to support animal life.

The fourth deposit was called the magnesian deposit on account of the assumption that the needle-like cavities were due to the crystallization of sulphate of magnesia. As needle-like crystals of sulphate of lime are well known, and as gypsum is abundant in this horizon, it seems more probable that these needle-like crystals were crystals of gypsum.

Prof. James Hall* describes the Salina group as follows: Succeeding the Niagara group is an immense development of shales and marls with shaly limestones including veins and beds of gypsum. The general color is ashy approaching drab with some portions of dark bluish green. The lower part is of deep red with spots of green. Succeeding this, where protected from atmospheric influences, the rock is blue like ordinary blue clays, with bands of red or brown. This portion and that succeeding it are often green and spotted, and contain seams of fibrous gypsum and small masses of reddish selenite and compact gypsum. From this it becomes gradually more gray with a thin stratum of clayey limestone, which is sometimes dark, though generally of the same color as the surrounding mass. The formation terminates upward with a gray or drab limestone called by Vanuxem the

* Geology of the 4th District.

'magnesian deposit." The red shale forming the lower division of the group is well developed, but in the third district has not been found west of the Genesee river. It appears in the eastern part of Wayne county as indicated by the deep red color of the soil which overlies it.

At Lockville a greenish-blue marl with bands of red has been quarried from the bed of the Erie Canal. West of the Genesee this is the last of the visible mass. The red shale has either thinned out or lost itself, gradually becoming a bluish green, while otherwise the lithological character remains the same. On first exposure it is compact and brittle, presenting an earthy fracture. But few days are necessary to commence the work of destruction, which goes on until the whole becomes a clayey mass. The prevailing features of the second division of the group are the green and ashy marl with seams of fibrous gypsum and red or transparent selenite often embracing nodules of compact gypsum. The third division comprises all the gypsum beds of the fourth district which are of economic importance. In this third division hopper-shaped cavities occur in Wayne and Monroe Counties, but rarely in Genesee or Erie.

There is scarcely any well defined division between the shales and shaly limestones of the third division and the so-called magnesian deposit which overlies it. This limestone in the western part of the state is used extensively for hydraulic cement and is now worked by the Buffalo Cement Co.

In their studies of the Salina group, Profs. Hall and Vanuxem found no rock-salt because this soluble mineral cannot remain at the surface. However from various wells and shafts, sunk during the past 11 years, we have sections of the Salina group which show the position and relation of the salt beds.

Through the courtesy of Prof. James Hall, State Geologist, I am permitted to quote the following synopsis of the record of the Livonia salt shaft, made under Prof. Hall's direction by Mr D. D. Luther.

## EXTRACT FROM THE REPORT OF D. D. LUTHER ON THE LIVONIA SHAFT

The mouth of the shaft is 260 feet above Conesus lake, 170 feet above Hemlock lake and 1082 feet above sea level. The first 10 to 12 feet of the drift penetrated was a fine loamy gravel with large boulders of gneiss and smaller blocks of limestone, principally from the corniferous or water-lime groups. Below that deposit veins of clay and quicksand saturated with water were encountered. At 64 feet the bed rock was reached.

### SYNOPSIS OF RECORD

| Depth | Thickness | |
|---|---|---|
| 380 feet | | Beginning of recorded section. |
| | 6 feet | bluish gray shale. |
| 386 | | |
| | 29 feet | compact dark blue shale. |
| 415 | | |
| | 1 foot | hard gray limestone. |
| 416 | | |
| | 11 feet | hard medium dark blue shale, somewhat calcareous. |
| 427 | | |
| | 2 feet | blue gray limestone. |
| 429 | | |
| | 1 foot | soft blue gray shale. |
| 430 | | |
| | 1 foot | fine pinkish gray limestone. |
| 431 | | |
| | 7 feet | blue shale with concretionary layers. |
| 438 | | |
| | 2 feet | hard limestone containing considerable pyrites. |
| 440 | | |
| | 7 feet | soft blue compact, pyritiferous shale. |
| 447 | | |
| | 20 feet | soft blue gray shale. |
| 467 | | |
| | 9 feet | dark blue, slightly pyritiferous shale. |
| 476 | | |
| | 2 feet | concretionary layers with silicified fossils. |
| 478 | | |
| | 17 feet | blue shale, hard and calcareous. |
| 495 | | |
| | 27 feet | dark brownish bituminous shale. |
| 515 | | |
| | 28 feet | dark bluish gray soft shale. |
| 543 | | |
| | 4 feet | soft bluish pyritiferous shale. |
| 547 | | |
| | 8 feet | harder arenaceous and pyritiferous shale. |
| 555 | | |
| | 5 feet | sandy shale with thin layers of impure limestone. |
| 560 | | |

| Depth | Thickness |
|---|---|
| | 2 feet light gray limestone. |
| 562 | 4 feet sandy shale, quite hard. |
| 566 | 4 feet fine bituminous shale. |
| 570 | 34 feet soft dark rock. |
| 604 | 6 inches hard sandy dark bluish gray shale. |
| 604′ 6″ | 3 feet 4 inches soft dark bluish shale. |
| 607′ 10″ | 1 foot 2 inches hard calcareous sandy layer. |
| 609′ | 6 feet dark bluish soft shale. |
| 615 | 11 feet harder dark blue shale. |
| 626 | 3 feet sandy layer, quite hard. |
| 629 | 21 feet dark brownish and bluish gray shale. |
| 650 | 147 feet dark brown or black shale, with bluish |
| 797 | or olive layers. |
| | 15 *feet very bituminous shale, bottom of Hamilton.* |
| 812 | 11 feet black bituminous shale. |
| 823 | 2 feet compact gray limestone. |
| 825 | 4 feet of black bituminous shale. |
| 829 | 22 feet of black shale, very bituminous. |
| 851 | 1 foot bluish black shale. |
| 852 | 2 feet black impure limestone. |
| 854 | 2 feet blue black grayish limestone. |
| 856 | 1 foot impure limestone. |
| 857 | 6 feet black shale. |
| 863 | 3 *feet black hard shale, bottom of Marcellus.* |
| 866 | 22 feet gray limestone with chert. |
| 888 | 66 feet gray limestone containing chert. |
| 954 | 24 feet gray limestone full of chert very hard. |
| 978 | 20 *feet* 6 *inches gray limestone containing less* |
| 998′ 6″ | *chert, bottom of corniferous.* (*Gas.*) |
| 1001′ | 2 feet 6 inches gray limestone, no chert. |
| | 5 *feet hard green and gray sandstone* (*Oriskany*). |
| | Containing pebbles and fragments of hy- |
| 1006 | draulic limestone. |
| | 4 feet bituminous dark colored hydraulic lime- |
| 1010 | stone. |

| Depth | Thickness | |
|---|---|---|
| | 14 | *feet hydraulic limestone, light colored, bottom of water-lime.* |
| 1024 | | |
| | 6 | feet very light gray sandstone. |
| 1030 | | |
| | 39 | feet hydraulic limestone. |
| 1069 | | |
| | 9 | feet hard bluish gray shaly rock, with black seams. |
| 1078 | | |
| | 9 | feet blue gray hard shale, with nodular layers of gypsum. |
| 1087 | | |
| | 6 | feet fine brownish gray limestone, with light blue gypsum in masses from 1 to 4 inches thick. |
| 1093 | | |
| | 25 | feet hydraulic limestone, with gypsum in crystals and nodules. |
| 1118 | | |
| | 17 | feet dark bluish gray shales; gypsum in nodules |
| 1135 | | |
| | 3 | feet reddish brown limestone, with dark gypsum in nodules. |
| 1138 | | |
| | 45 | feet *gypsum bed* dark bluish gray marl, intercalated with gypsum in layers and nodules, sometimes one foot or more in thickness. |
| 1183 | | |
| | 9 | feet light reddish gray limestone; gypsum in layers from one-half inch to one foot. |
| 1192 | | |
| | 5 | feet layers of limestone and gypsum. |
| 1197 | | |
| | 1 | foot of reddish gray limestone. |
| 1198 | | |
| | 3 | feet bluish gray marl with gypsum in nodular layers. |
| 1201 | | |
| | 2 | feet red gray limestone. |
| 1203 | | |
| | 2 | feet bluish gray marl. |
| 1205 | | |
| | 15 | feet limestone. |
| 1220 | | |
| | 6 | feet bluish marl; gypsum in nodular layers. |
| 1226 | | |
| | 7 | feet reddish brown limestone. |
| 1233 | | |
| | 1 | foot bluish gray marl, with nodular layers of gypsum. |
| 1234 | | |
| | 4 | feet reddish gray limestone. |
| 1238 | | |
| | 2 | feet yellowish gray, very hard, limestone, gypsum in small crystals. |
| 1240 | | |

| Depth | Thickness |
|---|---|
| | 1 foot limestone. |
| 1241 | 8 feet limestone, gypsum in crystals. |
| 1249 | 6 feet red and yellow limestone, with layers of |
| 1255 | bluish gypsum from one to six inches thick. |
| | 3 feet yellowish gray limestone. |
| 1258 | 8 feet bluish gray marl; gypsum in layers some |
| 1266 | of them from 6 to 12 inches thick. |
| | 12 feet yellowish and reddish limestone; gypsum in seams and veins, hopper shaped |
| 1278 | crystals, at 1274 feet. |
| | 7 feet marl, much gypsum in nodules and |
| 1285 | masses. |
| | 2 feet light brown marl; gypsum abundant in |
| 1287 | nodules. |
| | 9 feet soft light bluish marl, much gypsum in |
| 1296 | masses and nodules. |
| | 3 feet hard fine brownish gray limestone; (*gas* |
| 1299 | *in small quantity*). |
| | 1 foot light gray soft limestone; gypsum in |
| 1300 | seams. |
| | 11 feet dark gray hard limestone. |
| 1311 | 3 feet hard fine slightly reddish limestone, gyp- |
| 1314 | sum in thin seams. |
| | 2 feet yellow gray bituminous limestone. |
| 1316 | 1 foot bluish gray marl. |
| 1317 | 6 feet light gray, reddish gray limestone, hop |
| | per shaped crystals; gypsum in thin seams |
| 1323 | and veins. |
| | 2 feet yellow and light gray limestone; gyp- |
| 1325 | sum in seams and veins. |
| | 3 feet of limestone, bluish gray. Gypsum in |
| 1328 | thin veins. |
| | 3 feet yellow bituminous limestone; thin veins |
| 1331 | of light gypsum. |
| | 6 feet very hard gray limestone. |
| 1337 | |

| Depth | Thickness | |
|---|---|---|
| | 2 feet | yellowish gray limestone, white crystallines; gypsum in small thin veins. |
| 1339 | | |
| | 4 feet | pinkish gray limestone; gypsum in seams and veins. |
| 1343 | 11 feet | brownish-gray hard limestone. |

At 1348 feet the first salt found was observed in a few thin veins, in some of which the vein matter was of salt, in others the wall matter was crystalline gypsum with which a thin layer of salt was intercalated. The salt was pinkish or cream color; the gypsum was white or pink.

| | | |
|---|---|---|
| 1354 | 1 foot 6 inches | marl bluish gray, salt and gypsum in veins. |
| 1355′ 6″ | 6 inches | nodular layer of gypsum. |
| 1356 | 2 feet | dark gray limestone containing a large percentage of salt and crystals in nodules. |
| 1358 | 2 feet | bluish gray marl, with many seams and veins of salt. |
| 1360 | 6 inches | very thinly laminated limestone, with salt in seams. |
| 1360′ 6″ | 8 feet 6 inches | bluish gray marl, with many cracks filled with white and pinkish crystalline salt; considerable gypsum. |

At 1369 feet at the south end of the shaft a bed of nearly pure coarsely crystalline salt was reached, which on the east wall of each shaft showed a dip of 1 foot on the upper line of contact, and 4 feet 8 inches on the lower toward the north, the layer being 8 inches thick at the south end and 3 feet at the northeast corner. A small proportion of shale is mixed with the salt.

| | | |
|---|---|---|
| 1369 | 4 feet | marl with pink, milk colored salt in veins and seams, gypsum present, not abundant. |
| 1375 | | |
| | 2 feet | transparent salt in large fine crystals, mingled with marl. |
| 5377 | | |

| Depth | Thickness | |
|---|---|---|
| | 1 foot 6 inches bluish marl, becoming light blue on exposure; little salt; gypsum | |
| 1378′ 6″ | abundant. | |
| | 11 feet mixed salt, coarsely crystalline, and marl in flakes and small fragments pres- | |
| 1390 | ent throughout the bed. | |
| | 13 feet salt. | |
| 1403 | 3 feet 6 inches dark gray hard limestone con- | |
| | taining much salt in veins, seams and | |
| 1406′ 6″ | crystals. | |
| | 2 feet 6 inches gray limestone soft; pinkish | |
| 1409 | salt in veins and seams. | |
| | 1 foot 6 inches very soft bluish marl; pinkish | |
| 1410′ 6″ | and white salt in seams and veins. | |
| | 15 feet six inches white and pink salt in large crystals with fragments and flakes of marl | |
| 1426 | in varying proportions. | |
| | 2 feet dark gray hard limestone. | |
| 1428 | 4 feet green marl with red and pink salt in | |
| 1432 | thin layers. | |

In this section 408 feet of Salina strata are penetrated below the bottom of the water-lime formation, the bottom of the well being 566 feet below the bottom of the Corniferous. Probably there is as much as 500 feet of Salina strata with salt beds below the bottom of the shaft. It is, therefore, not certain that more than the upper half of the group is exposed in this section. It is noteworthy that much gypsum overlies the salt.

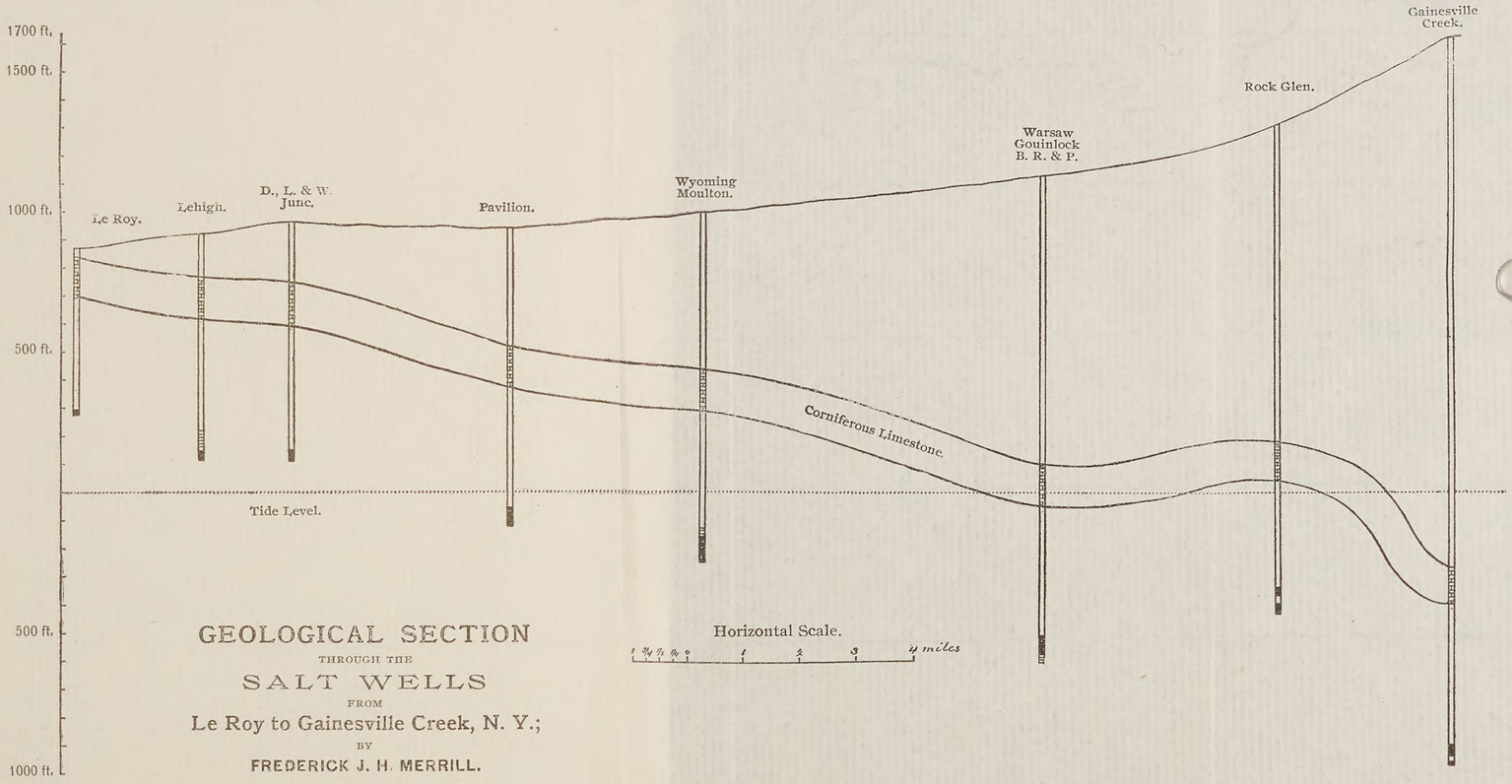
## ALTITUDE OF THE SALT BEDS

In the Oatka-Genesee salt district the number and wide distribution of the wells and shafts supply data with regard to the altitude and attitude of the salt deposits which permit of certain generalizations. The measurements of the various wells make it possible to construct a map of the

underground contours of the salt measures, which accompanies this report.

In constructing this map the contours have been located 610 feet below the upper surface of the corniferous limestone; for the salt beds vary greatly in their thickness and position in the Salina group, and it is necessary to assume an horizon at which the occurrence of salt can be expected. The contour line at the altitude chosen intersects the principal salt bed in nearly every well and shaft.

Throughout the Oatka-Genesee district, salt is usually found at levels varying from 550 to 750 feet below the upper surface of the corniferous limestone. The exceptions to this are very few; the only ones which have come to the notice of the writer being the wells at Nunda and Bliss, in the former of which, salt was found between 450 and 500 feet below the corniferous, and in the latter it was first met at a depth of 900 feet. In the Ithaca well the lowest bed of rock salt was over 1000 feet below the upper surface of the corniferous. The testimony of the two latter wells would suggest that as a rule the wells and shafts of western New York have penetrated little more than half way through the salt measures. The upper surface of the corniferous limestone has been taken as the datum plane from which to determine the relative positions of the salt beds, because it is invariably recognized by the driller as soon as reached. Its persistent character and the abundance of chert distributed through it, form a marked contrast with the comparatively soft shales and thin limestones which overlie it. From the underground contours as shown on the map, it will be seen that the dip of the strata in western New York is not directly to the south, but nearly south-east at the rate of about 60 feet to the mile. The section as plotted between Le Roy and Gainesville Creek shows that the beds do not slope uniformly to the south east but undulate in that direction.




# GEOLOGICAL SECTION

THROUGH THE

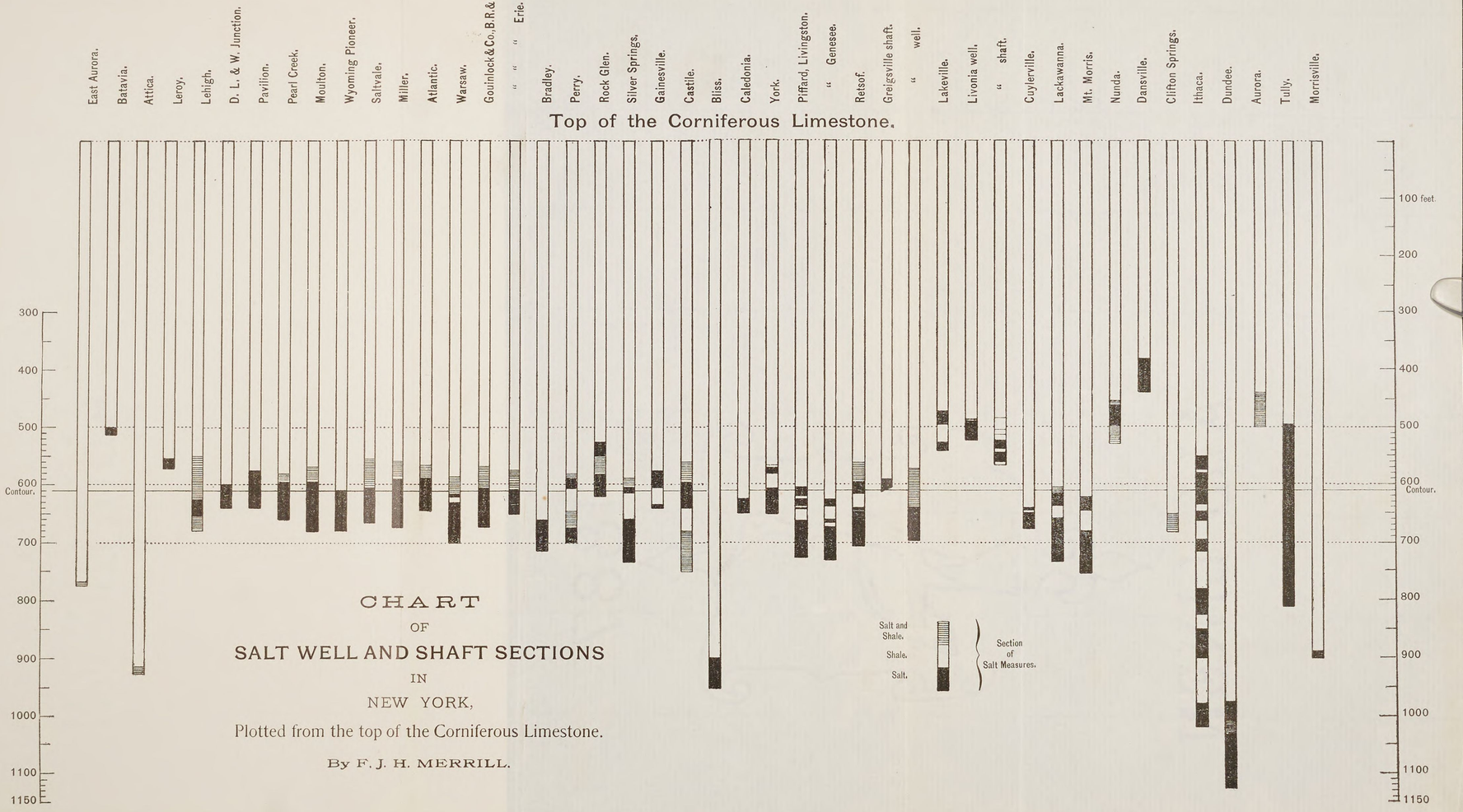
# SALT WELLS

FROM

## Le Roy to Gainesville Creek, N. Y.;

BY

FREDERICK J. H. MERRILL.




# CHART

OF

# SALT WELL AND SHAFT SECTIONS

IN

NEW YORK,

Plotted from the top of the Corniferous Limestone.

By F. J. H. MERRILL.

The chart of well sections shows the relations of the salt beds to each other and to the corniferous limestone.

## WELL BORING AND TUBING

The method of boring wells for salt is similar in every respect to that in use in boring for oil or gas. The matter of principal importance is the method of tubing the well.

This subject has not been exhaustively studied for this report and only a few details are here given.

At Tully an 8 inch pipe is first sunk through the surface drift to the bed rock; inside of this a 6 inch hole is drilled through the salt deposits. This hole is tubed sufficiently far to cut off all surface water from the well. Inside of this 6 inch pipe a 3 inch pipe is suspended, being coupled to the pipes for brine and water in such a manner that water may flow down through the 3 inch pipe and up through the 6 inch or vice versa. The well is then operated by forcing water down one pipe into the salt beds where it takes salt into solution and becomes more or less nearly a saturated brine. The brine under pressure, rises to the surface through the other pipe, flows through a conduit to Geddes and is used in the manufacture of soda-ash. For the first six months after a well is bored the fresh water passes down through the 3 inch tube and the brine rises through the space between the tubes; afterwards the method is reversed.

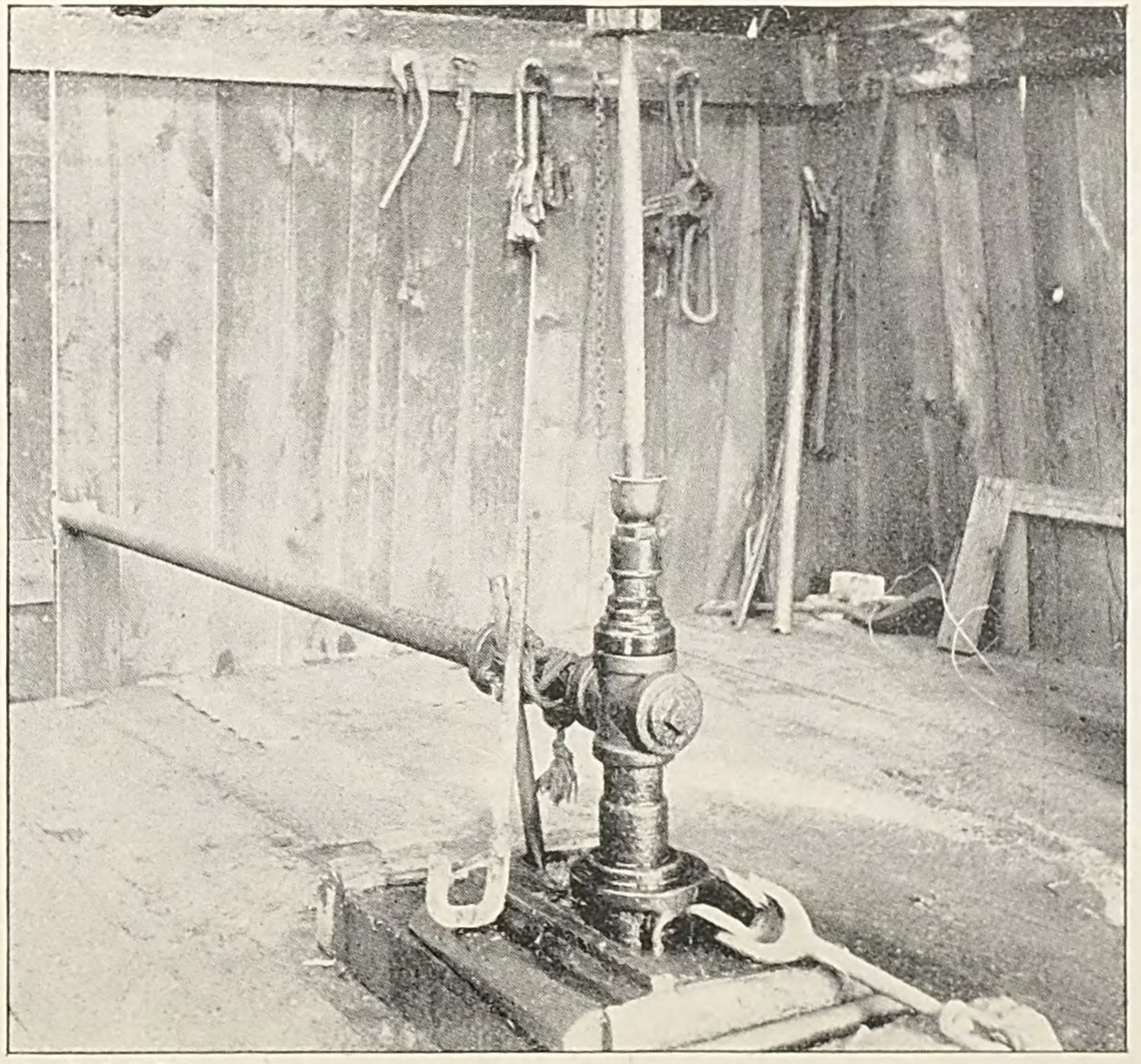
At Tully water is brought to the wells with a natural head sufficient to force the brine to the surface without the use of pumps. In the Warsaw district it is sometimes customary to allow the surface water to flow into the well and pump out the resulting brine. This is done by the Miller Salt Co.

The Miller Salt Co. runs the pipe down to the bottom of the well in order to secure only the saturated and heavier brine. The water is outside of the pipe furnished and comes both from above and from springs tapped in the hole. The brine is pumped up inside the pipe. This method necessitates but one hole, differing from the plan of having

holes, one for forcing the water in and the other for the saturated brine to rise in.

The wells of the Kerr Salt Co. are what are known as "forcing wells," i. e. the wells are combined and the water from the Oatka Creek being forced down by means of a common Cameron or Deane pump. These wells are arranged to prevent the back pressure on the pump, which would result if there were only one well, as the amount of water is distributed over several wells instead of one. The wells have an outside ring of iron called the "casing" and an inside ring called the "tubing" through which the fresh water is forced in. The rock on which the casing rests is reamed out level to fit the end of the casing and cement is used to make the joints tight. The tubing is secured in a collar at the top which rests at the upper end of the casing. This is what supports the weight of the rods and this weight serves to prevent the brine at a pressure of 250 lbs. or so, from escaping. The water becomes saturated and is forced up the pipe in the other well to the tanks.

At the Duncan Salt Company's works at Silver Springs, fresh water is taken from springs and is pumped into the wells. The method of forcing in at one well and out at another is employed for connected wells. In all cases the water is forced down on the outside of the tubing between the casing and the tubing, and comes up through the tubing whether one well is used or whether the wells are connected. The fresh water from the springs is first pumped through a Cameron pump. It goes down the wells outside the tubing, dissolves the salt layers, rises in the tube as saturated brine and is discharged in a tank. The method of tubing is as follows: A 12 inch pipe is first sunk down to the rock. Then a drill of about 6 inches diameter is used and the hole bored deeper to firm rock and the casing is put in. Then the tube hole of 4 or 5 inches is bored. The casing is put in and the lower part packed with rubber which fits in between the rock and the casing and prevents the leakage of



Neg. by I. P. Bishop.

BRINE PUMP. ATLANTIC SALT CO'S WORKS, WARSAW, N. Y.

brine as well as the inflow of surface water. The rubber has the whole weight of the casing to support and therefore fills all crevices. This is brought about by breaking joints in the casing so that the whole weight comes on the rubber. The weight of the tube comes on the thread of the collar and tube above, the collar resting on the casing head. This weight is enough to keep the brine from leaking out at the top, at a pressure of about 300 lbs. If the pressure of the brine should happen to be sufficient to overcome the weight of the tube the collar would rise in its seat and the brine flow off at the top.

Wells which are connected are reversible, that is to say, water can be pumped down one and up the other alternately.

At Saltvale the process of pumping employed by the Crystal Salt Co. is based on the theory that it is preferable to take the brine from as low a depth as possible, because there is a tendency for the strong brine to become stronger at the expense of the weaker brine above, and besides, the brine on account of greater specific gravity sinks to the bottom below the water. For this reason it is better to pump brine up the tubing rather than up the casing because the tube is forced to take the saturated brine while the casing, not being down to the bottom, as it ends several hundred feet above, is forced to take the less saturated brine.

The forcing principle, i. e. the forcing down one and up another, is said to have been invented by the Crystal Salt Co. and is used by them for connected wells and isolated wells. The capacity is obviously greater for there is no limit to the amount of water which may be forced into a well except the capacity of the pumps and the size of the cavity already made, a larger cavity producing a greater degree of saturation, on account of a longer period of contact with the salt. In the old method in which a lifting pump is used the capacity depends on the cylinder and length of stroke.

Caving in of the rock frequently causes much trouble. The rock becomes undermined by the dissolving out of the

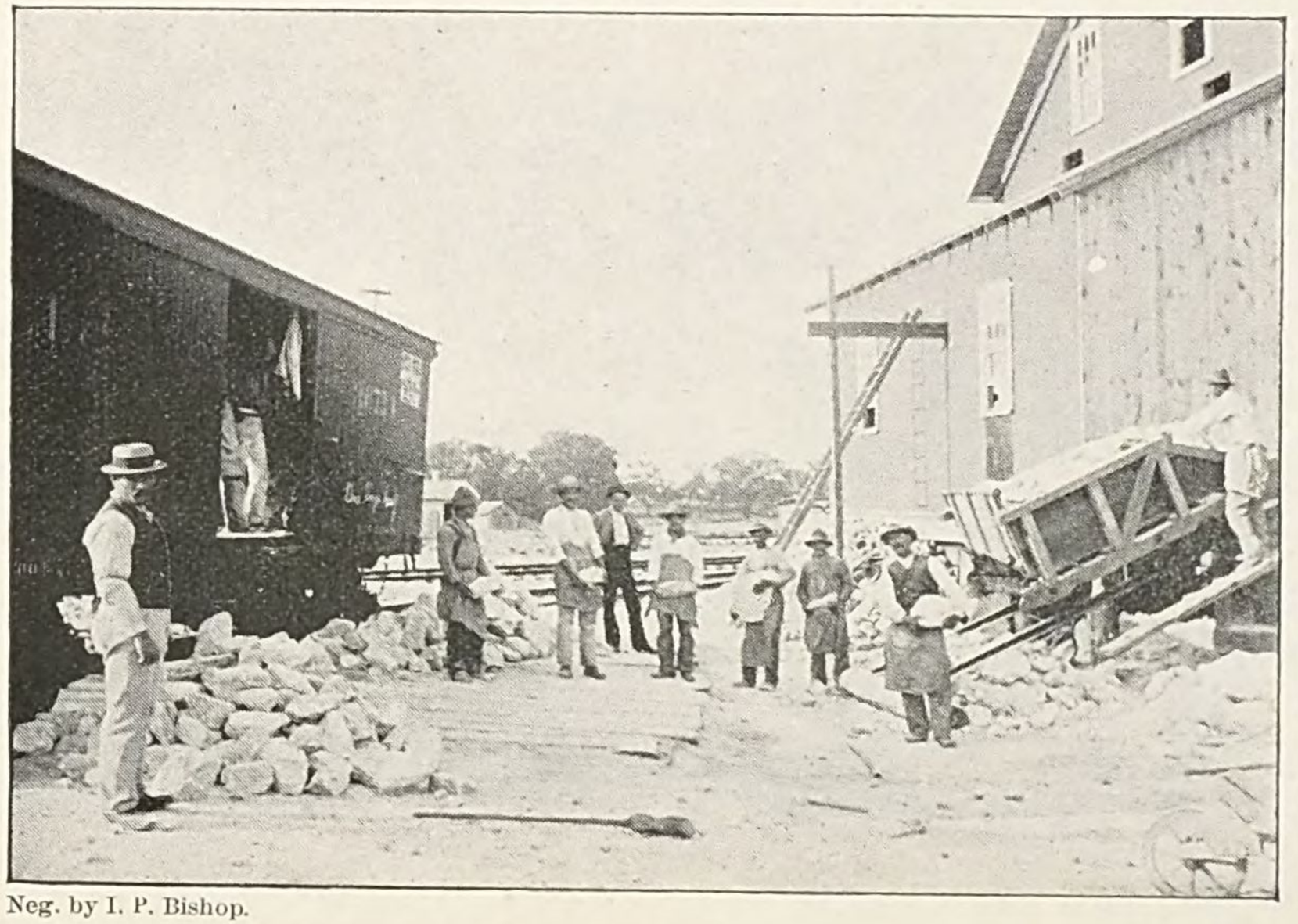
brine and falls down, blocking the work and often breaking the pipe for some hundreds of feet.

## MINING OF ROCK-SALT

The mining of rock-salt is briefly described by F. E. Englehardt, Ph. D. as follows:

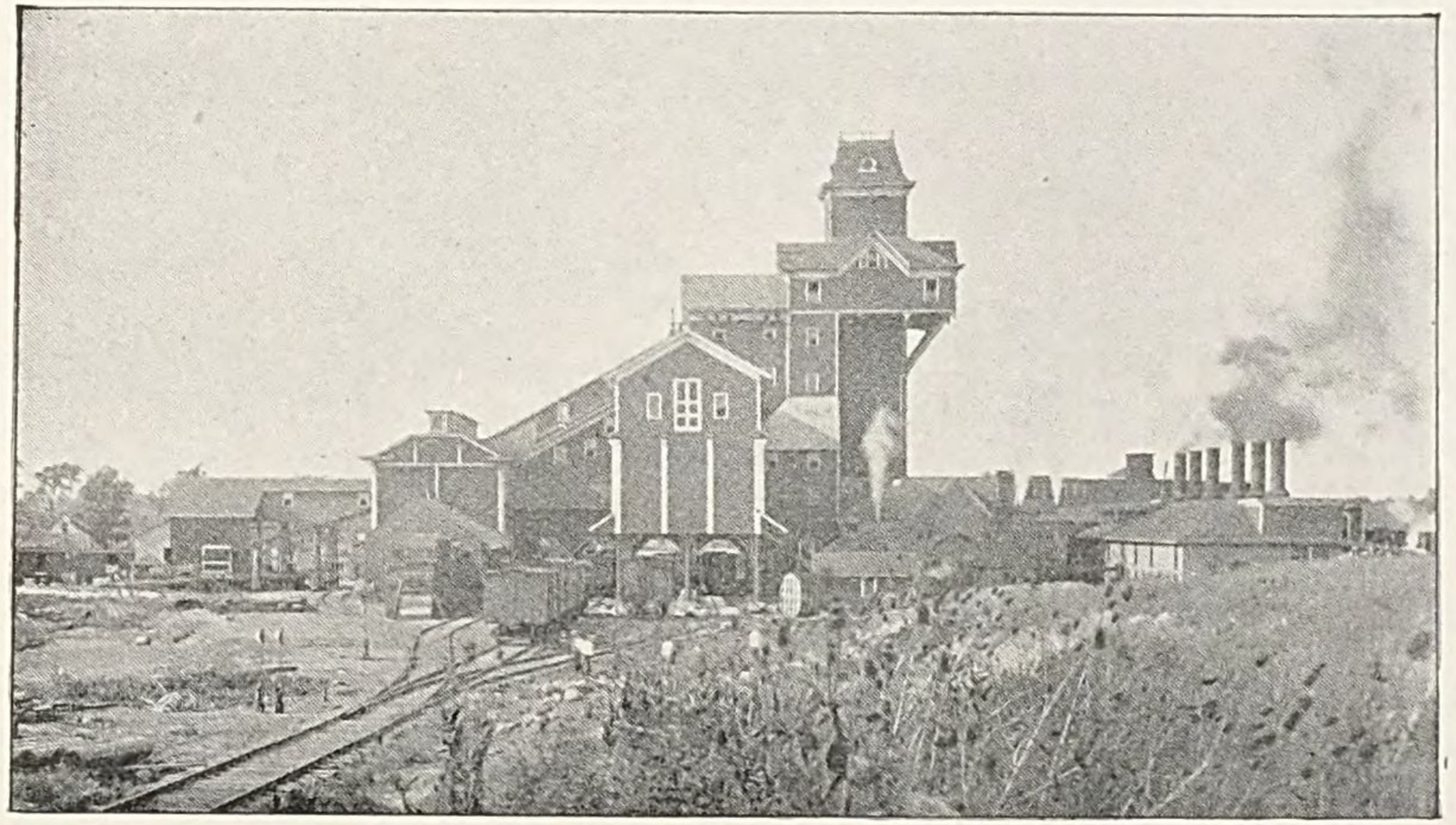
Rock-salt mining in the State of New York dates from November 1885, when the first shaft belonging to the Retsof Mining Company, situated near Piffard, Livingston Co., reached the underlying salt bed. Since then and within the last two years a second shaft has been sunk about 2 miles south of Le Roy in Genesee County by the Lehigh Salt Mining Company. A third one was finished several months ago at Livonia, Livingston County, and a fourth one is just finished at Greigsville in the same county, about 2 miles west of the Retsof shaft.

The sinking of the shafts is done in the usual manner. The sides are protected from caving in by heavy timbers and to prevent water from entering the shaft a heavy layer of cement is put between the walls of the shaft and the timber. The size of the shafts vary somewhat, the usual dimensions are 12 feet by 18 to 24 feet square in the clear. The main galleries are about 30 feet wide, their height depending on the thickness of the salt beds. Some salt must always be left as a roof and floor, hence in a vein of salt 24 feet thick an allowance of 6 feet for the roof and 4 feet for the floor would give a gallery or chamber 14 feet in height. From the main chambers cross sections or galleries are run every 30 feet, thus the roof above is supported by pillars 30 feet square. The salt is blasted out with dynamite. The drills are run by compressed air about 6 feet into the solid salt and they are set in such a manner that when the blast takes place as much as possible of the salt remains in lumps. The salt is loaded into small cars which are run on tracks laid on the floors of the chambers to the shaft on to the cages, by which they are carried or hoisted



Neg. by I. P. Bishop.

LOADING LUMP SALT. RETSOF MINE, RETSOF, N. Y.



Neg. by I. P. Bishop.

SALT BREAKER. RETSOF MINE, RETSOF, N. Y.

to the top of the breakers, similar to those used in coal mining and from 100 to 145 feet above the surface of the ground. To separate the lump salt from the finer material the contents of the cars are dumped on a set of iron bars, which permit all the salt to fall through into the crusher below except the lumps, which are loaded onto other cars and run down an incline to the ground, where they are stored, usually in the open air, for shipment. The finer material passes through the crushers on to sieves and from the latter into the bins. Of the crushed and sifted salt there are four kinds according to size. The lump salt is mainly used for stock, the other grades for the same purposes for which sea or solar salt is used.

The quality of the mine salt may be learned from the following analysis of an average sample (A) and perfectly white salt (B).

| | A | B |
|---|---|---|
| Moisture ..... ..... | a trace | a trace |
| Insoluble.... ..... ..... .... | 0.7430 per ct | 0.0584 per ct |
| Sulphate of lime (calcium sulphate).. | 0.4838 " " | 0.0793 " " |
| Calcium chloride ..... ... ... .... | 0.0180 " " | 0.0358 " " |
| Magnesium chloride... ..... | 0.0546 " " | 0.0888 " " |
| Pure salt..... ... | 98.7006 " " | 99.7410 " " |

## TECHNOLOGY OF MANUFACTURE

The salt of commerce is derived from sea water, from natural brine, from artificial brine made by dissolving rock salt, and directly from the latter by crushing and grinding.

Salt is derived from sea water in three principal ways: by solar evaporation in pits, by the aid of frost and by heat. The separation of salt from sea water by solar evaporation is carried on along the Atlantic coast of Europe, i. e. in Portugal, Spain and France as far north as 48° of latitude. On the Mediterranean coast the separation of salt from sea water is carried on in France and Spain, in Italy on the Tyrrhenian and Adriatic Seas, and by Austria on the shores of Istria and Dalmatia. In these regions the sea water is allowed to flow into a series of tanks formed by excavation

or by building dykes. In the first of these the water stands for a time in order that all material in suspension may settle. From the settling tank the water flows into smaller basins where, by evaporation, the salt crystallizes out. Salt may also be separated from sea water by the application of the principle that at a temperature of 1° below the freezing point of water, brine separates into ice which is nearly pure and a strong fluid brine. If the ice be removed and the remaining fluid be allowed to freeze again, another portion of the water separates as ice and there finally remains a brine from which salt separates after slight evaporation. In order to procure a cleaner product before evaporation the brine may be purified with lime, by which the salts of magnesia are decomposed. The separation of salt from sea water by the aid of fuel is carried on in Normandy and also at several places in England, at Ulverstone, Lancashire, at Lymington on the coast of Hampshire and on the Isle of Wight.

According to Charles A. Goessman all known brines as well as rock salt may be divided into two classes, those which contain besides common salt, chloride of calcium, chloride of magnesium, and sulphate of calcium and those which contain only chloride of magnesium and chloride of calcium, sulphate of magnesia and sulphate of soda All brines east of the Mississippi including those of Goderich belong to the 1st class, while the 2nd class occurs in Nebraska. Sea water also belongs to the 1st class. Sulphate of lime and soda within proper limits are far less objectionable than chlorides of lime or magnesia. The brines of Syracuse, Goderich and Saltville, Va., contain less of the latter than those of Michigan, Ohio and Pennsylvania.

## THE MANUFACTURE OF SALT IN THE STATE OF NEW YORK

By F. E. Englehardt, Ph. D

The practical manufacture of salt from salt brines in the state of New York dates from the year 1788, when an Indian discovered to Col. Comfort Tyler a salt spring at

## Brine Analyses by F. E. Englehardt, Ph. D.

### WYOMING VALLEY BRINES.

| | | | | | Pearl Creek | | Warsaw. | Le Roy | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Specific gravity ..... | 1.18984 | 1.19933 | 1.2050 | 1.19705 | 1.1924 | 1.20446 | 1.2045 | 1.1920 | 1.19544 | 1.17106 |
| Ferric oxide* ..... | not determ. | 0.00266 | not determ. | not determ. | not determ. | not determ. | not determ. | not determ. | 0.0038 | 0.0027 |
| Calcium sulphate .... | 0.3754 | 0.34257 | 0.2570 | 0.3840 | 0.433 | 0.401 | 0.443 | 0.3083 | 0.4307 | 0.51336 |
| Calcium chloride .... | 0.2717 | 0.31507 | 0.0680 | 0.1370 | 0.069 | 0.140 | 0.135 | 0.5268 | 0.1074 | 0.15070 |
| Magnesium chloride.. | 0.0990 | 0.07863 | 0.0050 | 0.0370 | 0.142 | 0.322 | 0.053 | 0.1034 | 0.0408 | 0.07167 |
| Sodium chloride..... | 24.5282 | 25.16640 | 26.300 | 25.3630 | 25.008 | 25.564 | 25.711 | 23.5819 | 24.6749 | 21.55320 |
| Water..... | 74.7257 | 74.90467 | 73.3700 | 74.1790 | 74.342 | 74.573 | 73.958 | 75.4796 | 74.7424 | 77.70837 |

### GENESEE VALLEY BRINES.

| | | | | | | | Livingston Salt Co. |
|---|---|---|---|---|---|---|---|
| Specific gravity ..... | 1.1820 | 1.18399 | 1.20114 | 1.1913 | 1.2033 | 1.1931 | 1.1891 |
| Ferric oxide*... .... | not determ. | 0.00159 | 0.00156 | 0.0109 | not determ. | not determ. | not determ. |
| Calcium sulphate .... | 0.3739 | 0.36623 | 0.41391 | 0.4555 | 0.5790 | 0.3394 | 0.3780 |
| Calcium chloride ... | 0.4714 | 0.27980 | 0.20260 | 0.5951 | 0.4650 | 0.3565 | 0.1913 |
| Magnesium chloride.. | 0.1970 | 0.07762 | 0.05126 | 0.1536 | 0.2125 | 0.1860 | 0.1897 |
| Sodium chloride..... | 22.8077 | 23.40173 | 25.33911 | 23.8983 | 25.3199 | 24.2827 | 24.1221 |
| Water.. ..... | 76.1500 | 75.87303 | 73.99156 | 74.8866 | 73.4234 | 74.8399 | 75.1189 |

### ONONDAGA BRINES.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Specific gravity ..... | 1.1456 | 1.1420 | 1.1422 | 1.14311 | 1.13362 | 1.1444 | 1.1420 | 1.1486 | 1.1470 |
| Ferric oxide*..... | not determ. | not determ. | not determ. | not determ. | not determ. | not determ. | not determ. | not determ. | not determ. |
| Calcium sulphate .... | 0.5401 | 0.5431 | 0.5440 | 0.4969 | 0.4399 | 0.3632 | 0.5531 | 0.5141 | 0.4232 |
| Calcium chloride .... | 0.1373 | 0.1453 | 0.1340 | 0.2140 | 0.2009 | 0.5701 | 0.0966 | 0.1693 | 0.2615 |
| Magnesium chloride.. | 0.1618 | 0.1197 | 0.1790 | 0.1031 | 0.1876 | 0.2852 | 0.1368 | 0.1547 | 0.1551 |
| Sodium chloride..... | 18.3440 | 17.7673 | 18.0560 | 18.9430 | 17.4662 | 18.4277 | 18.5595 | 19.0646 | 19.0525 |
| Water..... | 80.8168 | 81.4246 | 81.0870 | 80.2430 | 81.7054 | 80.3538 | 80.6540 | 80.0973 | 80.1077 |

* The ferrous carbonate was determined as ferric oxide and is given as such.

N. B.— The source of most of the above brines is withheld by Dr. Englehardt because the analyses were made in a confidential capacity.

the foot of Salina heights now in the city of Syracuse. Col. Tyler commenced at once the manufacture of salt. In the same year, on September 12, the Onondagas sold to the state of New York the so-called "Salt Reservation," comprising the lands for one mile round Onondaga lake, for the purpose of making salt. Thus the state became the owner of the lands and the salt brine. In the year 1793 the first laws regulating the manufacture of salt were passed and William Stephens was appointed the first superintendent of the "Onondaga Salt Springs." In the same year the first arch with four potash kettles was erected by William Van Fleck and Moses De Witt. Strange as it may seem, the same method for the manufacture of boiled salt is practiced to-day on the Reservation, with this difference, that now one arch contains from 30 to 50 kettles and that there are two arches. The next method for the manufacture of salt was brought from the sea coast of Massachusetts in the year 1821–22. It was the manufacture of a coarse salt by solar evaporation in shallow wooden vats. When, in the western part of the state, rock salt was discovered in 1878 the Michigan Grainer and the European pan soon made their appearance.

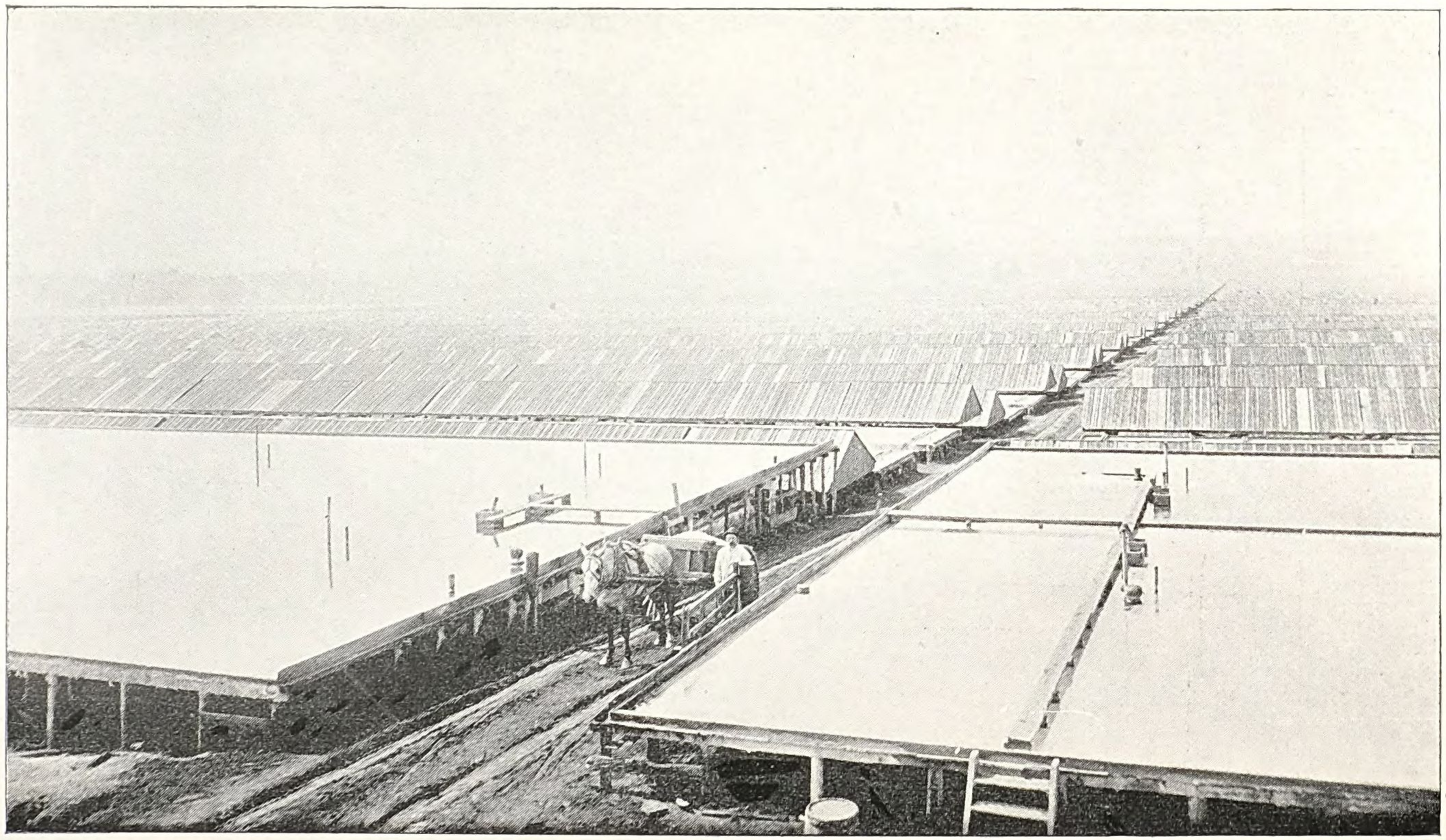
The processes employed to-day in the manufacture of salt in the state of New York are as follows:

1 Solar evaporation.
2 Direct fire evaporation. { Pan process / Kettle process
3 Steam evaporation. { Kettle with steam jacket / Grainer process
4 Vacuum pan evaporation.

## 1 SOLAR EVAPORATION

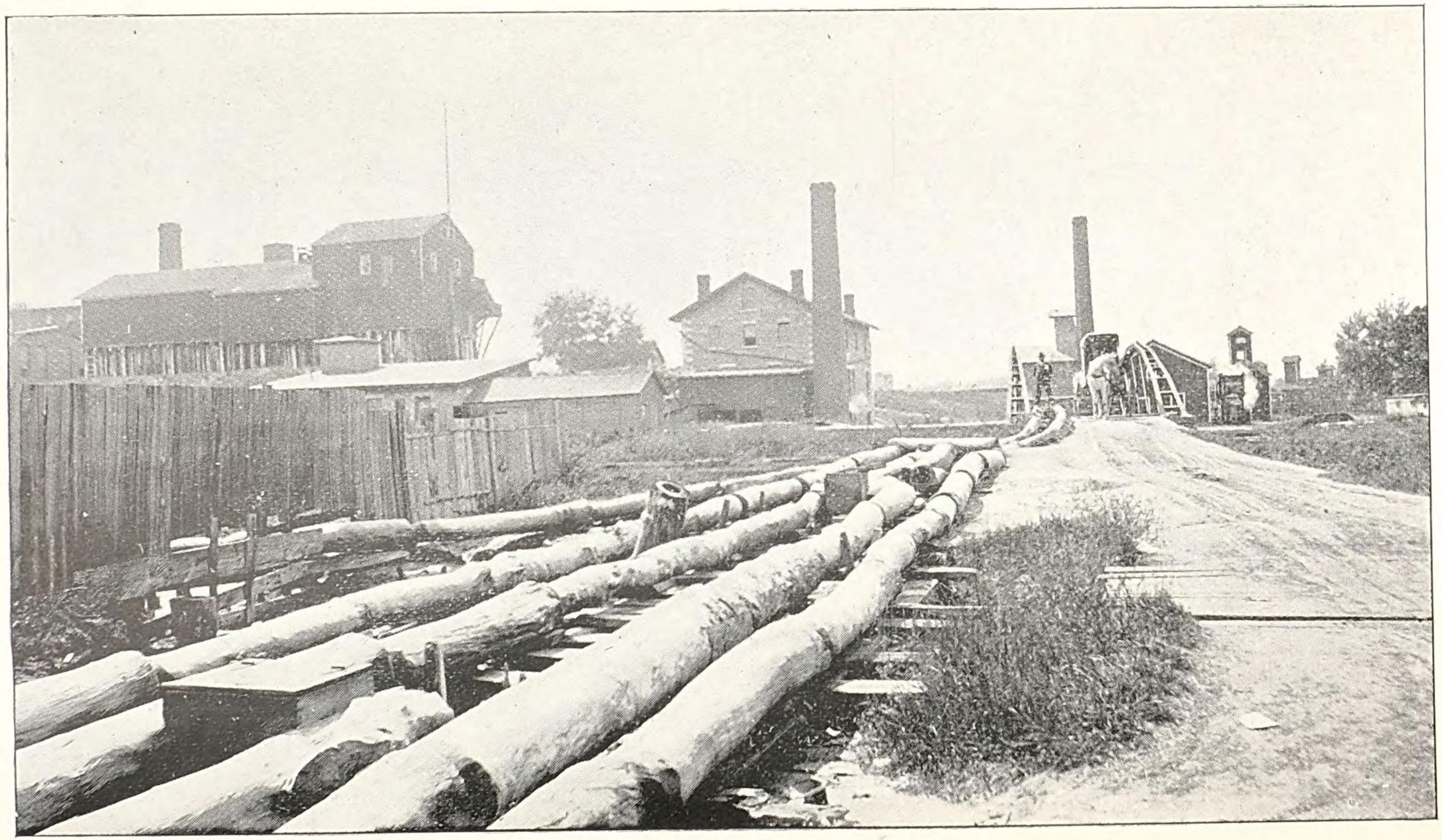
The manufacture of solar salt, or as it is often called, coarse salt, is carried on in shallow wooden vats which, in order to protect the contents against rain, are provided with movable wooden covers, running on wooden rollers. At the end of the season the wooden rollers are removed and the covers or roofs fastened securely on the vats.

There are three sets of these vats, or as they are more familiarly called, rooms. The first are called "deep rooms," and serve for the reception of the brine as it comes from the wells or pumphouse. The brine when received in these rooms is usually perfectly clear, but soon it becomes turbid and of a yellowish red color. This change is due to the escape of carbonic acid gas with which the brine is highly charged when it comes from the wells and by which the trace of ferrous carbonate present is held in solution. The solvent escaping, the ferrous oxide takes up oxygen and separates from the brine as a hydrated ferric oxide in a very finely divided state, causing a yellowish turbity, which disappears gradually as the ferric oxide settles to the bottom of the vat, and leaves the brine clear again. The deep rooms are constructed higher above the ground than the following set, which are called "Lime rooms," — (this is a misnomer, since in the manufacture of solar salt lime is never used) — in order to enable the workmen to draw from them into the lime rooms as occasion requires. The evaporation of water from the brine which commences in the deep rooms, continues in the lime rooms till the brine reaches its point of saturation which is recognized by the workman, when small cubic salt crystals make their appearance. While the brine is evaporating and becoming saturated a second change takes place in it, namely, a certain amount of sulphate of lime or gypsum separates from it in beautiful crystals on the sides and bottom of the room. This separation is especially marked when the brine is near its point of saturation. The now fully saturated brine is called pickle and is drawn into the third or lowest set of rooms, called the salt rooms. Here another change takes place. Salt and a portion of the remaining sulphate of lime crystallize out, the former in more or less perfectly developed cubic crystals, the latter in fine slender crystals often twinned. As the evaporation of the water from the pickle progresses, the salt crystals first



Neg. by I. P. Bishop.

SOLAR SALT PLANT, SYRACUSE, N. Y.



Neg. by I. P. Bishop.

PUMPING WORKS AND PUMP-LOGS, SYRACUSE, N. Y.

formed increase in size, new ones make their appearance and soon the entire bottom of the room is covered with them. It is the custom of the manufacturer, while this is going on, to introduce a sufficient amount of saturated pickle from the lime rooms to replace the evaporated water and thus keep the salt well covered.

Since the brine contains besides salt, ferrous carbonate and gypsum, other constituents ; namely, potassium, calcium and magnesium chlorides and magnesium bromide; a comparison of the chemical composition of the brine with that of the pickle is but proper in this place. From Dr. Goessmann's* experiments it appears that a brine having the chemical composition given under No. 1, produces a pickle of the composition given under No. 2.

| | No. 1 Brine | No. 2 Pickle |
|---|---|---|
| Specific gravity..... | 1.1225 | 1.2062 |
| Calcium sulphate .... ..... | 0.5772 per cent | 0.4110 per cent |
| Calcium chloride ..... | 0.1533 " " | 0.2487 " " |
| Magnesium chloride ..... | 0.1444 " " | 0.2343 " " |
| Potassium chloride ..... | 0.0119 " " | 0.0194 " " |
| Magnesium bromide ..... ... | 0.0024 " " | 0.0039 " " |
| Ferrous carbonate..... | 0.0044 " " | |
| Sodium chloride ..... | 15.5317 " " | 25.7339 " " |
| Water..... | 83.5747 " " | 73.3488 " " |

In this experiment Dr. Goessmann employed 1010 parts of the above brine and obtained 623 parts of pickle, while 3.28 parts of calcium sulphate had crystallized out and 383 parts of water evaporated. While, then, the ferrous carbonate had been entirely removed and the calcium sulphate decreased more than one half, the salt and the soluble calcium and magnesium chlorides had increased in the proportion of their original quantities. Whenever a sufficient amount of salt has accumulated in the salt rooms it is harvested. This occurs about three times during a season. The process consists in raking it together on the side of the room next to the road and putting it into small perforated

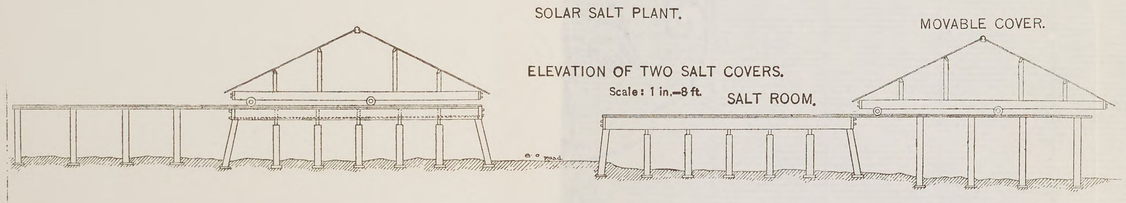
* "Report on the manufacture of solar salt, etc." Syracuse 1864.

tubs, to drain off as well as possible the adhering calcium and magnesium chlorides, since they impart to the salt a sharp bitter taste and keep it from becoming properly dry, as they are very deliquescent, absorbing moisture rapidly from the air. This being accomplished the salt is dumped into the salt cart and drawn to the storehouse. Since the gathered salt consists of crystals of various sizes, many manufacturers pass it, as it comes from the salt yard (the name given to these works) into the storehouse, over a wire screen with $2\frac{1}{2}$ meshes to the square inch, kept in motion by hand or steam power. While the unscreened salt is called 'Standard Coarse," that which passes over the screen is known as "Diamond C. ◇C◇." and the portion passing through the meshes "Diamond F. ◇F◇."

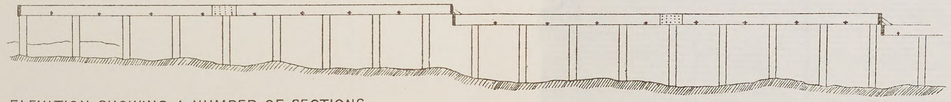
Of the three kinds of rooms belonging to a salt yard about one-third are deep and lime rooms, the rest are salt rooms. These rooms are usually 18 feet wide; their length depends often on the extent of the yard, and it may be therefore from 100 to 500 feet and more. In a properly constructed salt yard, where the salt rooms are of great length, they are built in a number of sections in such a manner that the floor of the first one is some 6 or 8 inches higher than that of the next one, and the floor of this one again the same number of inches higher than the third one and so on. The advantage of this arrangement is obvious, for it enables the manufacturer to keep the fresher pickles separated from the older ones, since, when the time of harvesting arrives he can discharge the pickle from the lowest section and draw onto the salt the pickle from the section above less charged with the deliquescent chlorides, for the purpose of removing as far as possible from the salt with this newer pickle the adhering chlorides and fine needle like gypsum crystals.

The depth of the rooms varies from 6 inches for lime and salt rooms to 12 and 14 inches for deep rooms. The movable covers are in 16-foot sections, capable of protecting a

SOLAR SALT PLANT.




ELEVATION OF TWO SALT COVERS.
Scale: 1 in.=8 ft.



ELEVATION SHOWING A NUMBER OF SECTIONS OF A SALT ROOM.

F. E. Englehardt, del.




PLAN OF ROOMS AND COVERS.
Scale: 1 in.=4 ft.

space of 16 x 18 feet square or 288 square feet. The size of the yard is estimated by the number of covers it has. During fair weather the covers are pushed aside wooden frames constructed for that purpose beside the rooms.

## SOLAR SALT "APRONS"

Within the last 15 years, the Onondaga solar salt manufacturers have adopted a plan by which some of them have increased their evaporating surface to a considerable extent, namely, they have added to their works, according to the space at their disposal, very large shallow vats from 20 to 100 feet wide by 200 to 2000 feet long and about 3 inches deep. Wherever practicable they are erected over the deep rooms (serving instead of roofs) thus making the latter practically store rooms. These vats or aprons, as they are called, are built in a similar manner to the vats previously described, on piles or posts. At certain distances from each other are two sets of holes provided with wooden plugs. The surface of these flat vats is so constructed that any brine or rain water on them will run rather slowly towards these holes. One set of holes communicates with the deep room. During fair weather a small quantity of brine is allowed to run into these vats, not exceeding one half inch in hight and it often becomes entirely saturated in one day, when it is discharged into the deep room below, and its place is taken by a fresh portion of brine to be evaporated. In case rain is expected the plugs over the deep rooms or cisterns are drawn, the brine runs off, the plugs are again inserted and those drawn out of the other holes, through which the rainwater runs off.

The advantages of this method are: first, a much more rapid evaporation due to the shallow layer of brine, and secondly, the gain of all the lime rooms for salt rooms. Ordinarily a solar salt yard with 2700 "Covers" 10 by 18 feet square, consists of 1800 salt rooms, 800 lime rooms and 100 deep rooms. By this improvement the salt rooms are

increased to 2600. Moreover the iron (ferrous carbonate) and the sulphate of lime (calcium sulphate) separate very quickly. When rain prevents the lime from becoming saturated, before it is discharged into the deep rooms or cisterns, it is returned to these aprons by a pump. The increase in the yield of salt per cover by this method over the old one is about 15 to 20 bushels per season according to the size of the aprons belonging to a yard.

The amount of salt produced in a solar field during a season depends not only on the state of the weather but also on the composition of the pickle from which the salt is deposited, since if the latter is too highly charged with calcium and magnesium chlorides due to keeping the old pickle over from season to season, evaporation may be greatly retarded thereby; in fact it may cease almost entirely, since whatever evaporation of water may take place in clear warm weather from a pickle overcharged with these chlorides, will be reabsorbed again by them during the prevalence of a damp moist atmosphere. The quality of the salt depends on the weather to a certain extent, but mainly on the intelligence and care of the workman. Supplying the salt rooms with perfectly saturated pickle, allowing the harvested salt (after properly washing it with newer pickle from the section above to remove adhering gypsum crystals and chlorides) to drain properly both in the tub and the storehouse and finally to discharge the old pickle at the proper time, are of the utmost importance in the manufacture of a good commercial solar salt.

According to the laws of the state the freshly harvested salt must remain 14 days in the storehouse before it can be put on the market.

There are at Syracuse about 43,000 covers with over 12 million square feet evaporating surface capable of producing 3,500,000 bushels during a season, which usually extends from the middle of March to the middle of November, according to the weather.

## 2 DIRECT FIRE EVAPORATION

There are two processes in use for the manufacture of salt by direct heat, namely :

A. The Pan Process
B. The Onondaga Kettle Process

### *A. Pan Process*

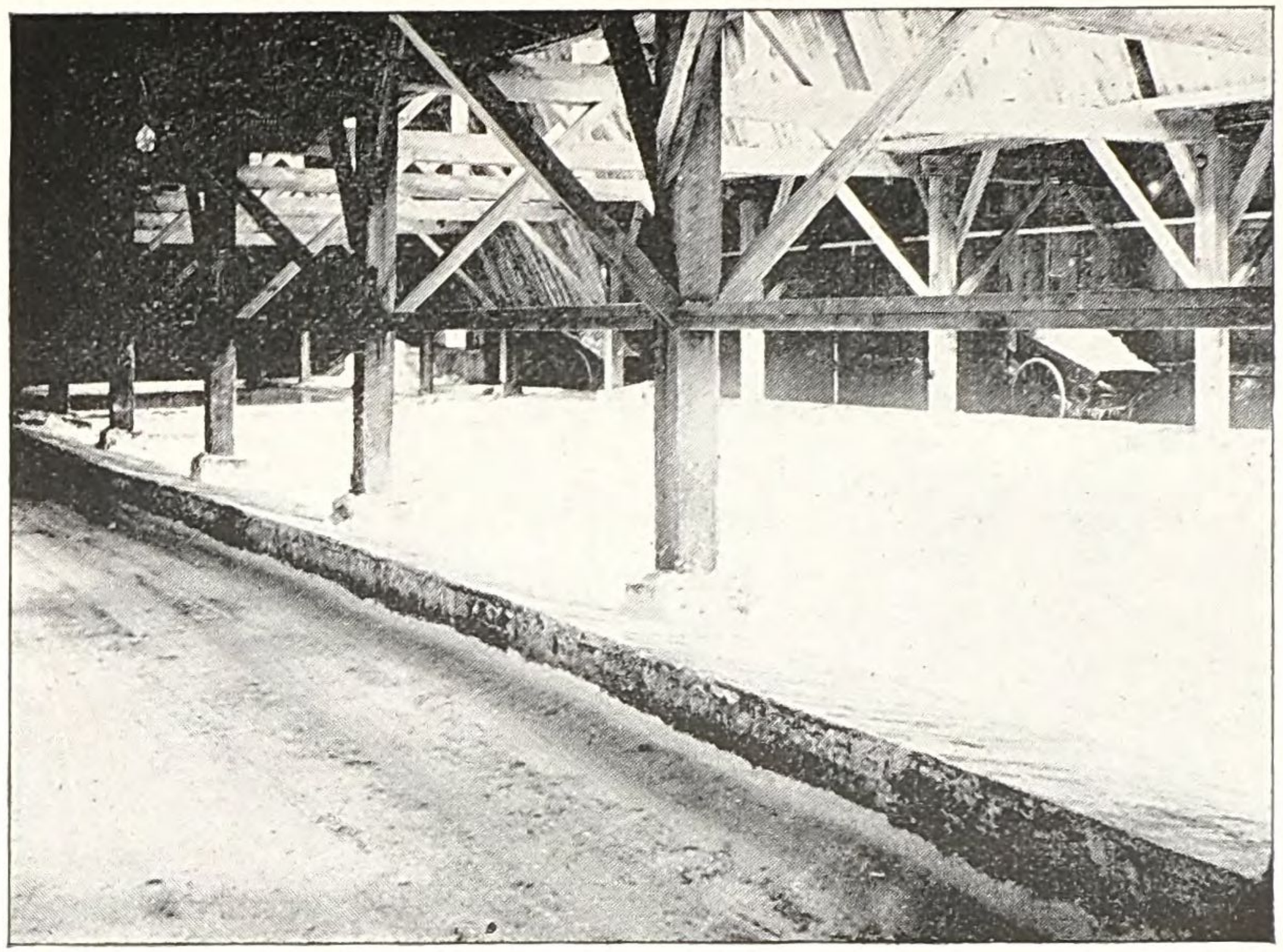
Usually several pans are placed under one roof. They are constructed of large wrought iron plates riveted together. The thickness of the plates is from $\frac{1}{4}$ to $\frac{3}{8}$ inch. The usual dimensions are: width 20 to 24 feet, length 100 feet in two sections and depth 12 inches. The front section is 70 feet and the back one 30 feet long, separated by a loose-fitting, wooden or iron partition, to allow the brine from the back section gradually to enter the front one. Adjoining the front pan is a back pan 30 feet long by 20 to 24 feet wide and 12 inches deep. The walls under this pan are from 12 to 16 inches higher to enable the easy transfer of the brine by syphon from the back to the front pan. The ends of these pans are at right angles to the bottom while the sides are oblique. The front pan is usually supported by two central and two outside walls (though there are some pans differently supported and constructed) which are 3 feet wide at their base and grates, tapering to one foot in width under the pan bottom. The distance from the top of the grate to the bottom of the pan is between 6 to 8 feet. The grates are 3 to 4 feet wide by 5 to 6 feet long. The walls are built in the most substantial manner and lined on the inside with fire brick in the front portion and with ordinary bricks farther back, where the heat is less intense. To protect the pan bottom against a too intense heat directly over the fires, a fire brick arch is built, the crown of which is between 2 and 3 feet below the pan bottom. This arch is solid from the front wall to about 2 feet beyond the grates, where an open space of 6 to 8 inches wide is followed by a second arch from 12 to 16 inches wide, and this again after an

interval by a third arch only a foot wide and so on. These arches are called rings and their width decreases from the front of the pan towards the end while the air spaces increase in width in the same direction. Beyond 20 feet from the front of the first section of the pan they cease altogether. To convey the heat as close to the pan bottom as possible, beyond the last arch, the flues are usually filled in with earth or plaster, and thus the distance between the pan and flue bottom is between 3 and 4 feet or even less, at the end of the first pan where a perpendicular wall, a so-called bridge wall, reduces the space to about 1½ to 2 feet, through which the products of combustion pass under the back pan and finally into a common chimney.

For the purpose of draining the salt, before it is conveyed to the storehouse an inclined wooden platform, the so-called "drip" is constructed along the entire length of both pans on either side, resting on the inclined iron sides of the pan.

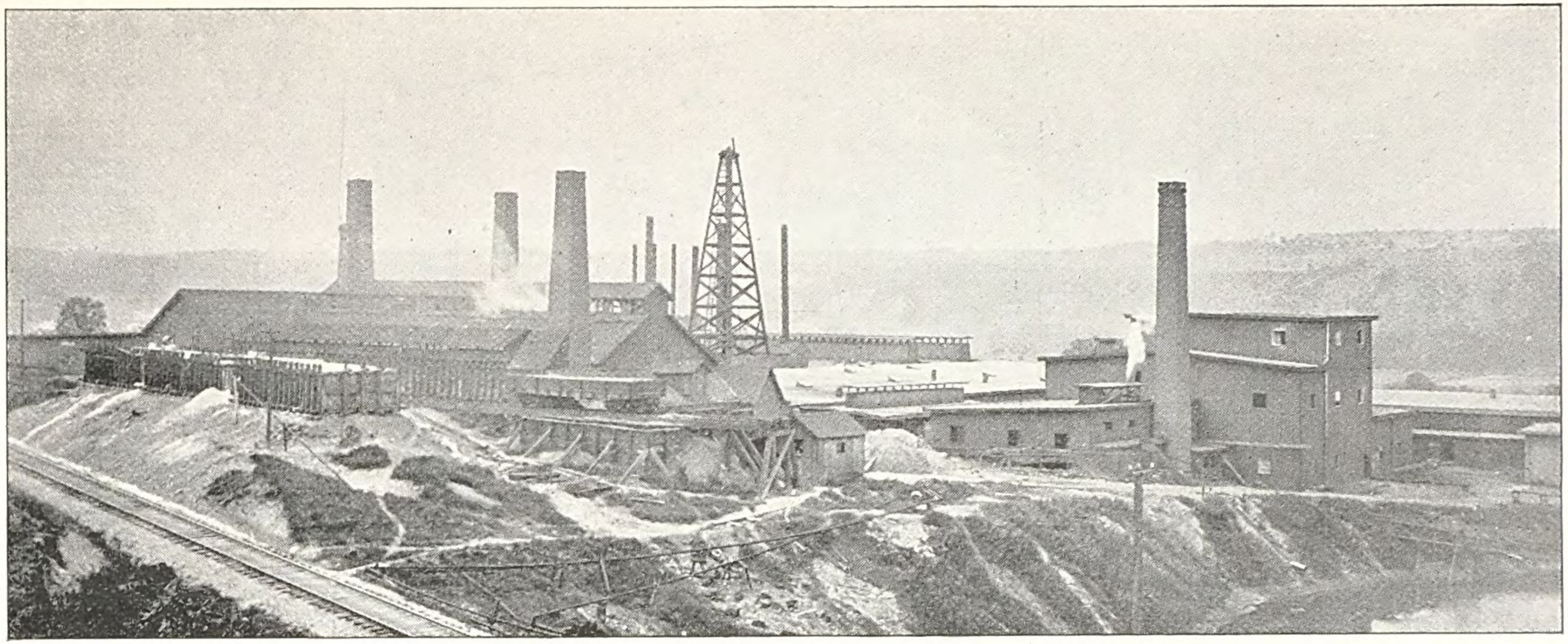
The so-called settling of the brine is the same as in the kettle method, with this difference, that the settled brine in consequence of the greater number of cisterns and their greater capacity remains for 4 to 5 days undisturbed. If it is the intention of the manufacturer to make the so-called "Factory Filled Salt" used for the dairy and the table, the settling with caustic lime is followed by a second settling with a certain quantity of carbonate of soda or soda ash as it is usually called by the workmen. The sodium carbonate is dissolved in salt water and the solution mixed with the brine. The carbonic acid unites with any caustic lime in solution in the brine, while the resultant caustic soda together with the greater quantity of undecomposed sodium carbonate decomposes the calcium and magnesium chlorides forming calcium and magnesium carbonates and common salt. Between the settlings with lime and sodium carbonate 12 hours are usually allowed to intervene.

After the pans are properly cleansed they are white-



Neg. by I. P. Bishop.

SALT PANS. GENESEE SALT CO'S WORKS, PIFFARD, N. Y.



Neg. by I. P. Bishop.

WARSAW SALT CO'S WORKS, WARSAW, N. Y.

Settling tanks are shown at the left.

washed with a thin milk of lime to prevent their rusting until they become thoroughly heated; the fires are started and the pans are filled by syphons to a depth of about 6 inches with brine from the back pans. The former are so inserted that a constant flow of brine passes from the back pans into the last section of the front pans and from these under the partition into the first section. Into the back pan flows a constant stream from the outside cistern until the front pans are sufficiently full, when the flow is stopped. After a sufficient amount of salt has collected in the first section of the front pan it is removed to the "drip" for drainage. This is called drawing or raking the pans. The front pans are refilled from the back pan, in which the brine has become considerably heated, and thus is prevented a too rapid cooling of the brine in the front pan which would seriously interfere with the formation of a properly grained salt. For the same reason the partition is placed in the front pan since it prevents any cold brine from coming suddenly into the first section, it being compelled to enter at the bottom of the pan where its temperature is the highest. The first drawing or "drip" usually contain traces of caustic lime in consequence of the white-washing of the pans and since this would be detrimental to butter, cheese, provisions, etc. salted with it, it is always kept separate and sent into the market as "agricultural" salt.

The following table gives the results of a series of analyses made on the contents of a pan to determine the relative increase of the chlorides of calcium and magnesium and the decrease of sulphate of calcium:

| | Calcium sulphate | Calcium chloride | Magnesium chloride |
|---|---|---|---|
| Original brine ..... | 0.3739 per ct | 0.4714 per ct | 0.1970 per ct |
| After running 24 hours.... | 0.2658 " | 1.2263 " | 0.3611 " |
| " " 48 " .... | 0.2009 " | 2.0213 " | 0.6895 " |
| " " 72 " .... | 0.1819 " | 2.6357 " | 0.9634 " |
| " " 96 " .... | 0.1116 " | 3.3843 " | 1.3197 " |
| " " 120 " .... | 0.0976 " | 4.9861 " | 1.8343 " |
| " " 144 " .... | 0.0686 " | 6.3569 " | 3.2316 " |

Total amount of deliquescent chlorides in the fresh brine ..... 0.6684 per ct

Total amount of deliquescent chlorides in the mother liquor... 9.5885 per ct

An increase of the chlorides of 14.345 times if we take 0.6684 equal to 100.

Thirteen hours of the 144 hours the pan was not boiling; this time being required to bring the pan to the boiling point and cool it again.

The great advantage of the pan process over any other is mainly in the controlling of the grain. According to the object of the manufacturer the salt can be made of any desired grain in a pan. When a fine-grained salt is desired, the fires are increased so that the brine in the first section boils over its entire surface. To aid in the formation of a fine grained salt (very desirable for dairy and table use) some artificial means are employed. Butter, specially prepared soft soap (of course made of the best lard or tallow and alkali) gelatine and white glue, are some of the substances added, and the quantities used are so insignificant in proportion to the amount of salt that they could not be detected even if they remained, but the hard soap, the lime soap, floats on the brine and is very carefully skimmed off. When this kind of salt is made the pans are "drawn" every 45 or 60 minutes. In the manufacture of coarser grained salt the "drawing" of the pans takes place at intervals of 2, 3, 4, 5, 6, or 12 hours according to the size of the grain, and the temperature of the brine is reduced from 229° Fahr. to 200° or even 148° Fahr. The storage room for the salt is usually in a separate building.

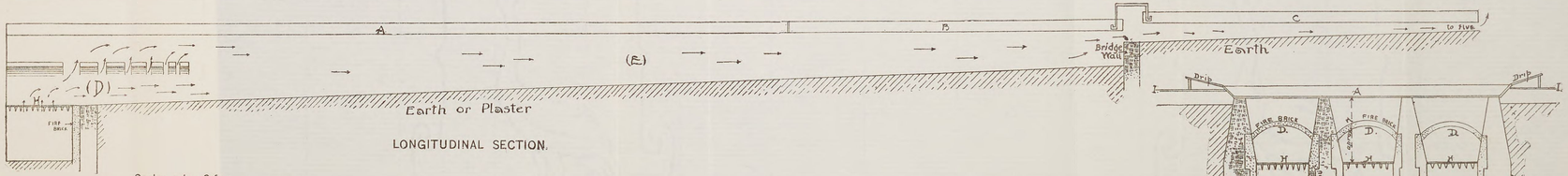
The amount of salt and its quality depends on the same conditions given under the kettle method. With good average coal dust and fair weather 80 to 90 bushels of salt per ton can be made in a well constructed pan during the summer season from saturated brine, which quantity will be reduced to 68 bushels during the winter months. A good average proportion for the entire year is about 1 ton to 72 bushels per ton with brine "up to saturation." The pan salt is always lighter than the kettle salt, bulk for bulk, since a pan never boils as rapidly as a kettle. Consequently the

PAN BLOCK.

A. Front pan, first section.
B. Front pan, second section.
C. Back pan.
D. Fire brick arches.
E. Flues.
F. Side walls.
G. Central walls.
H. Grates.
I. "Drip."

PLAN OF PAN BLOCK.




LONGITUDINAL SECTION.




TRANSVERSE SECTION

Scale: 1 in.=8 ft.

F. E. Englehardt, del.

calcium sulphate in the former is very rarely deprived of its water of crystallization, and therefore the pan salt will usually dissolve perfectly clear in water.

At the works of the Globe Salt Co. at Wyoming and at those of the Leicester Salt Co. at Cuylerville a modified pan process was used which is described as follows by Mr. I. P. Bishop:

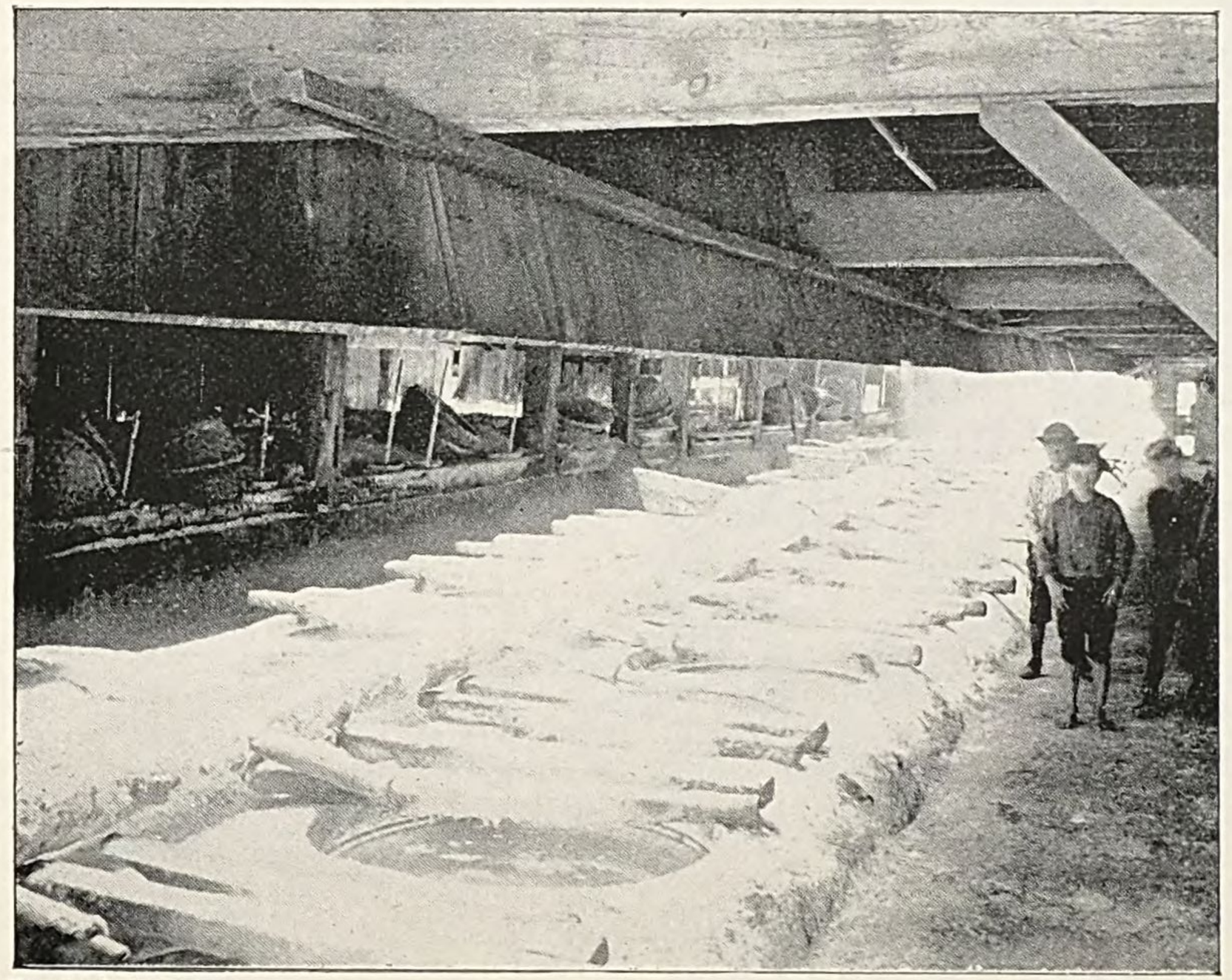
*The Lewis Process*

"The Lewis process is a modification of the pan process, and is so called from its inventor, Mr. Sylvester Lewis, of Rochester. The evaporating apparatus consists of ten pans 20 x 10 feet, each on an arch with its own grate and flue. There is also one long pan 15 x 100 feet with a grate at each end. The hot gases from the smaller flues are made to pass under the larger pan and thus lose the greater part of their heat before passing to the chimney. The brine is heated to 220° Fahr., in the larger pan to precipitate the gypsum, and then drawn to the smaller pans to be evaporated. The principal advantage claimed for this process over the preceding, is that any pan can be removed for repairs or for cleaning without stopping the work in the others."

*B. The Onondaga Kettle Process*

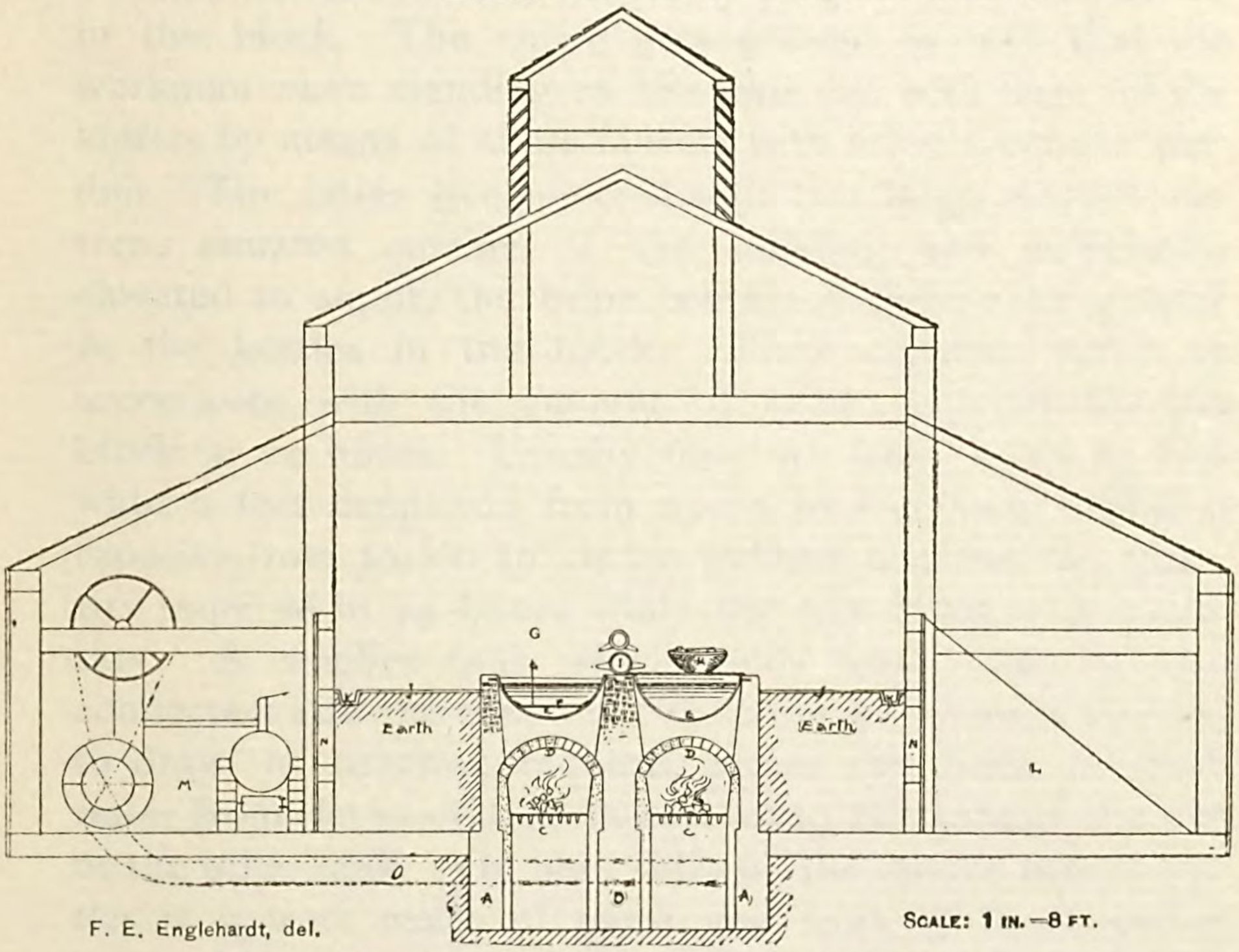
This is exclusively employed on the Onondaga Salt Reservation. A "Salt Kettle Block" usually called a "Kettle block" consists of from 60 to 100 hemispherical cast-iron kettles suspended or hung on "lugs" or pins in two parallel flues, called arches, ending in one chimney, which has a height of 50 to 100 feet according to the length of the flues. In front the arches are provided with cast-iron flat-topped grates 3 feet in width and 5 feet long, perforated with holes $\frac{3}{8}$ inch in diameter and one inch apart. These are well adapted for the burning of anthracite dust or culm which is now exclusively used for this purpose. The necessary artificial draft is furnished by a pressure blower. The kettles are from 22

to 26 inches in depth and from 3 feet 10 inches to 4 feet 2 inches in diameter, with a capacity of 100 to 150 gallons. The metal at the bottom of the kettle is 1¾ inches, and at the rim ¾ inch thick. The two lugs are 5 inches long by 1½ inches in diameter, situated about 4 to 5 inches below the rim and opposite each other. The arches or flues are formed by a central wall, 3 feet wide at the base and grate, and one foot wide on top, battering an equal amount on both sides and two side walls 18 inches wide at base and grate, battering on the inside to 8 inches on top. These walls are built of ordinary stone and lined on the inside with bricks. That portion of the walls which is especially exposed to an intense heat is lined with fire bricks, which is usually up to the 15th kettle from the front. The distance from the bottom of the kettle to the top of the grate is 3 feet 6 inches with a solid fire brick arch in each, extending somewhat beyond the length of the grate. The distance from the bottom of the kettle to the crown of this arch is 10 to 12 inches. Beyond the grate the fire brick arches are constructed in sections, the so called "rings" with air spaces between, which increase in size with the advancing distance from the grates. This construction allows the heated gases to pass through these spaces without striking the kettle bottoms directly. While the distance between the bottom of the front kettle and the top of the grate is 3 feet 6 inches, these flues decrease in depth as they advance towards the chimney, so that under the last kettle the distance is but 6 or 8 inches. The kettles are hung as close as possible with their rims against each other and the space between the walls and kettles above the lugs is properly covered by masonry, etc. for the purpose of confining all the heat as much as possible within the two arches. The two lugs enable the workman to hang the kettles perfectly free in the arches or flues, leaving an open space of several inches between the walls of the kettles and arches. Thus the heated gases in their passage from the grate to the



Neg. by I. P. Bishop.

INTERIOR OF A KETTLE BLOCK, SYRACUSE, N. Y.




TRANSVERSE SECTION OF KETTLE BLOCK.

A. A. Side walls.
B. Central wall.
C. C. Grates.
D. Fire brick arches.
E. E. Kettles.
F. "Bittern Pan."
G. Handle to "Bittern Pan."
H. Salt Basket.
I. Conduit for the brine from outside cisterns.
J. Walk.
K. Gutters.
L. Salt bins.
M. Engine room with Boiler, Engine and Blower, back of which is the salt bin.
N. Air space between walk and lining of salt bins.
O. Conduit for blast.

chimney are most effectually brought in contact with the entire heating surface of the kettles confined in the arches. The slanting of the walls and the gradually decreasing distance between the kettle and arch bottoms is specially designed to further this object. Lengthwise and a few inches above the central wall is a wooden conduit placed, provided with one faucet, and the necessary plug for each salt kettle, in the block. The entire arrangement is such that the workman when standing on the walk can with ease fill the kettles by means of these faucets with brine from the conduit. The latter is connected with two large wooden cisterns situated outside of the building and sufficiently elevated to supply the brine contained therein by gravity to the kettles in the block. Their capacity varies in accordance with the amount of brine required for the block in 24 hours. Usually they are from 20 to 25 feet wide, 6 feet deep and from 25 to 40 feet long, having a capacity from 30,000 to 40,000 gallons or about the quantity required in 24 hours, while the salt block is in operation. A smaller tank which holds fresh water is also connected with the conduit. Thus the workman is enabled to draw, as occasion requires, either salt brine or fresh water from the same faucets by closing the gate of the one or the other tank. On both sides of the double row of kettles is a walk made of earth and from 12 to 18 inches below their rims, for the use of the workmen in attending to the various operations connected with the manufacture of salt. It is from 5 to 6 feet wide extending the entire length of the block with a gutter running lengthwise of it and on the side farthest from the kettles to carry off any bitter water ("bitterns"), etc. requiring removal. Next to these gutters are the so-called "salt bins," having usually a depth from 6 to 8 feet below the level of the walk, a width of 10 to 14 feet and a length of nearly 100 feet and over, according to producing capacity of the block. They are always divided into several compartments

and serve as storage rooms for the manufactured salt. Their bottoms are made of 2 in. plank and are from 8 to 12 inches above the ground to permit the circulation of air under them and in order to provide for a proper drainage of the salt — the planks are not closely fitted. Since the heat in the front portion of the arch is so intense that it not only penetrates through the 18 inch brick wall and the five to six feet of earth adjoining but would also pass through the wooden lining of the bins, an air space of 8 to 12 inches is left between them to prevent any discoloration by "baking" of the salt stored in these bins. When the salt has been removed from these bins they are washed with fresh water for the purpose of dissolving any salt that may remain in the crevices of the bottom planks. The time during which these blocks are in operation extends from the middle of April to the first of December. Originally there were 316 salt blocks. Their number to-day is less than 100 and of these about 20 are in active operation.

The brine employed in the manufacture of boiled or common fine salt, as it is usually called, is the same as that used in the solar fields. Since the object of the manufacturer is to use the brine in the shortest possible time, and since there is present in it, as previously explained, carbonic acid gas, holding in solution some ferrous carbonate, it becomes necessary on the part of the workman to use some means to remove them both, since otherwise the salt would be discolored by ferric oxide. For this purpose he takes a small amount of quick lime, and slackens it with brine into a very thin milk, which he distributes evenly over the entire surface of the fresh brine. The lime unites with the carbonic acid to form calcium carbonate and the ferrous oxide takes up the necessary oxygen and water to form the hydrated ferric oxide, which gradually sinks to the bottom of the cistern. To assist this process as much as possible, the brine is well stirred whereby the caustic lime is brought in better contact with the brine and the removal of the carbonic acid

gas is more quickly accomplished. This being done the brine is allowed to stand from 20 to 24 hours, when the dirty yellowish color, which is soon visible after the addition of the lime milk, has disappeared, and a clear, slightly blue color takes its place. Thus prepared the brine is ready for the manufacture of salt. This process is called the settling of the brine. The manufacture proper of salt is commenced by lighting the fires under the kettles and filling them partly with brine from the faucets as soon as they become warm, and within 3 to 4 inches of the top when evaporation has well commenced. At the same time a wrought iron pan is inserted into the kettle, having its handle near the center instead of on the side to allow its easy insertion and withdrawal from the kettle. Otherwise it is like an ordinary frying pan, with very slanting sides, so that when it is inserted into the kettle it covers its bottom and fits as close as possible to the sides. This is known as the "bittern pan." Its purpose is to collect the sulphate of lime, "plaster" or "bitterns," which soon separates. This separation becomes more rapid with the increase of temperature and concentration especially near the boiling and saturation point of the brine. From the time the pan is first inserted till the brine actually boils or salt commences to separate, it is several times drawn out of the kettle and the sediment collected therein (the "plaster or bitterns") is thrown into the gutter beside the walk. That portion of the brine contained in the kettle which is nearest to its bottom and consequently becomes more strongly heated and therefore specifically lighter ascends along the inner side of the kettle. When it reaches the surface it is cooled by the cold air, becomes again specifically heavier and sinks back to the bottom of the kettle, but this time through the center, carrying with it into the pan the separated and finely divided calcium sulphate. When salt commences to separate the pan is withdrawn and the evaporation is allowed to go on undisturbed till a sufficient amount of salt has separated, when the con-

tents of the kettle are well stirred with the ladle and dipped into the basket resting on the so-called basket sticks laid across the rim of the kettle. While the process of taking the salt from the kettle is going on, the workman opens the faucet for a few minutes to add some fresh brine to the concentrated pickle of the kettle and washes the salt, so to speak, with this mixture, thereby freeing it as much as possible from the adhering calcium sulphate and the calcium and magnesium chlorides. The basket with its salt remains usually on the kettle for drainage till the kettle has to be "drawn" a second time, when the contents are dumped into the salt-bins beside the walk. The advantage of this method of drainage is readily understood when we bear in mind the fact that the rising steam or vapor given off from the brine of the refilled and boiling salt kettle below penetrates the salt in the basket, condenses to water and in its descent through the salt carries along some of the still adhering calcium and magnesium chlorides. The panning process, previously described, though carried out in the best possible manner will not completely remove from the kettle all the separated calcium sulphate, but some of it together with separated salt, will bake on the bottom and sides, forming an incrustation* constantly increasing in thickness, though at every refilling of the kettle with fresh brine, considerable of this adhering salt redissolves. This incrustation increases much more rapidly in the front kettles than in those nearer to the chimney, since a front kettle is usually drawn every 4 to 5 hours while a back kettle often requires from 24 to 36 hours before a sufficient amount of salt has separated. Moreover a front kettle holds 150 gallons of brine while those nearest the chimney contain but 100 gallons. Usually in 5 or 6 days the incrustation becomes so thick that it interferes very materially with the evaporation, causing a great

* The calcium sulphate left in the kettle after a good panning together with that which separates with the salt becomes in almost all the kettles heated sufficiently high to loose its water of crystallization and changes into so-called plaster of Paris, the workmen call it plaster of bitterns.

loss of fuel, as gypsum or plaster of Paris is one of the poorest conductors of heat. The workman therefore draws the salt from the kettle, removes the remaining salt brine, called pickle, to within a few gallons and refills the kettle with fresh water. After a continuous boiling of about half an hour the greater part of the adhering salt has dissolved and the rest of the incrustation can be readily removed.

The kettles properly cleaned are washed with fresh brine, refilled with the same and the boiling, panning and drawing of the kettles continues till the incrustations have accumulated not only in the kettles nearest the source of heat but also in those farther away towards the chimney. Now the fires are allowed to go out and at the same time the accumulated salt is removed from all the kettles. The old pickle or the mother liquor as it is also called, is dipped out as far as practicable into the gutter and the kettles are then refilled with fresh brine from which in the front kettles a considerable quantity of salt crystallizes, due to a partial evaporation of the brine by the heat retained in the arches. This salt is called "cool down salt;" it is much coarser than the boiled salt and usually kept separate. The time a salt block is in operation is between 10 to 15 days, a "10 or 15 days run." The manufactured salt having been all deposited in the bins, it is "leveled off" and according to the state law remains undisturbed for 14 days for drainage, when it is ready for the market. A salt block usually cools sufficiently in 12 hours, when the kettles, grates, arches, etc., are properly cleaned and made ready for the next "run." The time required for this is 24 hours, so that about two runs can be made in one month. The quantity of salt produced in 24 hours in a good salt block with average good coal dust and brine on the "Onondaga Salt Reservation" is from 500 to 600 bushels of 56 pounds each and the amount obtainable by the burning of one ton of 2000 pounds of this fuel varies from 45 to 50 bushels. These results depend mainly on the quality of the brine em-

ployed,* on the quality of the fuel,† the physical conditions of the latter, on the state of the weather, the temperature of the air, amount of heating surface, height of brine in the kettle, thinness of metal through which the heat has to be transmitted, on the more or less perfect combustion of the fuel, on the temperature at which the brine is evaporated, etc.

### 3 STEAM EVAPORATION

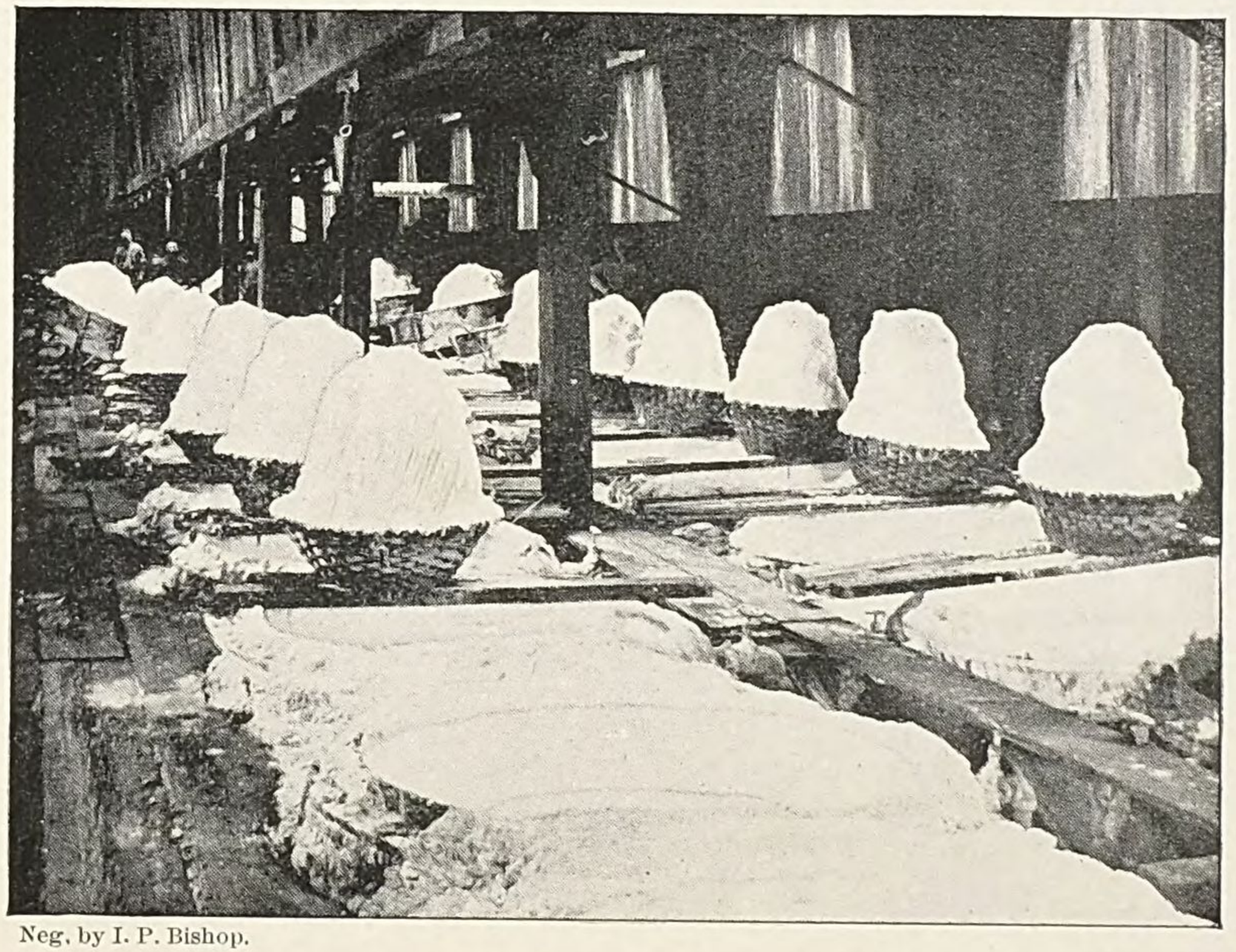
#### *Steam Kettle Process*

There are two salt blocks in the Wyoming Valley at Warsaw in which the Onondaga kettles are used for the manufacture of salt, but these kettles are heated by steam instead of direct fire. Hence in place of the brick arches in which the kettles are hung at Syracuse, they are supported by a frame work, and each kettle is surrounded by a steam jacket covered with a non-conductor. Moreover the metal of the kettle is made much thinner for the better transmission of the heat. The steam enters the jacket at the upper end of the kettle and at one side and the condensed water escapes by a valve below it, to be returned to the steam boiler. The method of manufacture of the salt does not differ in any particular from the Onondaga method. The heat of the steam being uniform for all the kettles, the salt produced is uniform in grain and very good in quality. The number of the kettles under one roof or in one salt block can be varied according to the wish of the manufacturer and the steam capacity of the boilers.

The quality of the salt is primarily dependent on the attention of the workman, on the chemical composition of the brine, on its proper settling, on the length of time a block has been in operation, and on the amount of calcium and magnesium chlorides present in the pickle, since an excessive heating of the front kettles, especially when they are

* See table of brine strength, etc., No. 1.

† See table 2. This table was compiled from Prof. W. B. Johnson's experiments made for the navy.



Neg. by I. P. Bishop.

STEAM KETTLES AND SALT DRYING IN BASKETS, ATLANTIC SALT CO'S WORKS, WARSAW, N. Y.

low in the pickle will cause a decomposition of the magnesium chloride into magnesium oxide and hydrochloric acid, the latter readily attacks the iron forming ferrous chloride, the slightest trace of which when present in the salt will cause a decided discoloration of the latter at the time the salt becomes ready for the market.

The grain of the salt, namely the size of the crystals, depends on the temperature at which the salt is made, and consequently on the quickness or slowness of the evaporation. The separation of the salt or its crystallization in a heated brine begins at the moment when the latter has reached its point of saturation. This crystallization always takes place on the surface of the brine and never at the bottom, since there the temperature is highest, and salt is more soluble in the hotter brine. The little cubes will increase in size as long as they remain on the surface of the brine but not when they have once sunk to the bottom of the heated liquid. Hence, to produce a coarse salt, the brine must remain as much as possible undisturbed in order to allow the crystals to grow, which is impossible in a very hot brine.

The salt made by the ordinary kettle method is not of a uniform grain or crystal, since the front kettles, which usually boil very rapidly yield a heavy salt of which the crystals are small, hard and sharp to the touch, while the back kettles produce a very light, flaky and coarse grained salt very soft to the touch. By mixing both a good grained average salt is obtained, which is known in the market as "common fine salt."

The average composition of this is about as follows:

| | | |
|---|---|---|
| Sulphate of lime (calcium sulphate) | 1.30 | per cent. |
| Calcium chloride | 0.16 | " |
| Magnesium chloride | 0.15 | " |
| Sodium chloride salt | 95.49 | " |
| Moisture | 2.90 | " |

Since the year 1862 there has been produced at Syracuse a salt of very superior quality for the dairy and table, the

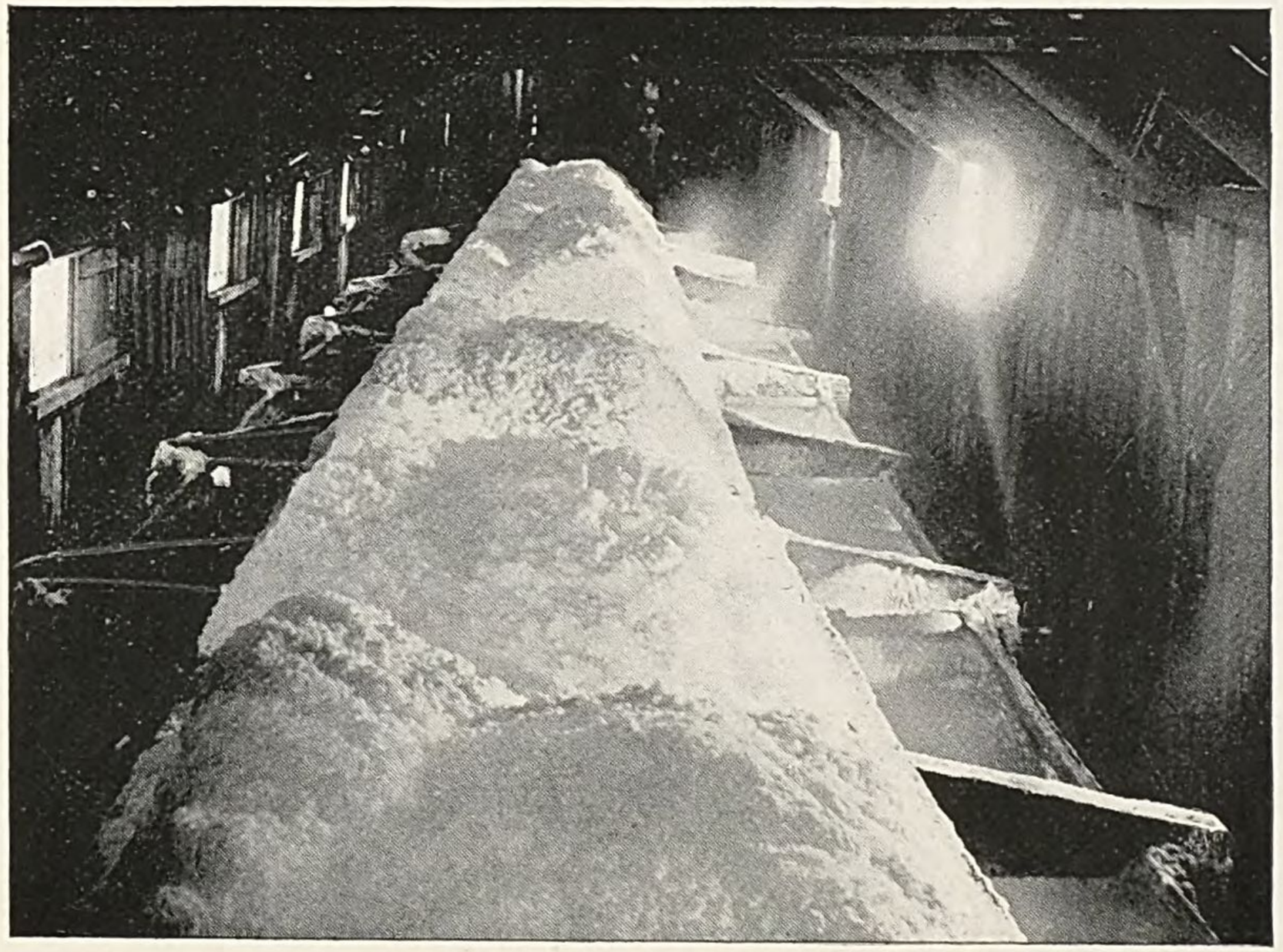
manufacture of which has of late been abandoned. The process consisted in washing the common fine salt described above in a machine with a pure salt pickle holding in solution the necessary amount of sodium carbonate for the decomposition of the small percentages of calcium and magnesium chlorides, yielding salt and calcium and magnesium carbonates in a very fine state of subdivision, which readily floated off with the brine or pickle together with some of the calcium sulphate adhering to the salt. After proper drainage the salt was dried in large iron dryers lined with wood (the so-called "Hersey Dryer"), ground and sifted. The peculiar tendency of Onondaga boiled salt, when dissolved in water, to impart to the latter a milky appearance, is due to the presence of calcium sulphate in the anhydrous state, known as plaster of Paris. If the solution be allowed to stand for some time this plaster will take up its water of crystallization and redissolve.

There are at present about 40 separate wells in 5 groups on the reservation. The brine comes within 18 to 22 feet of the surface. They are all tubed with 6 or 8 inch tubes and the brine is drawn from them by plunger pumps. The brine obtained from them is very similar in chemical composition, as the following examples prove.

| | Gere well | Hoffman well | S. Smith well | Dewolf well | McCrain well | Backer well |
|---|---|---|---|---|---|---|
| Depth ..... ..... | 256 ft. | 309 ft. | 285 ft. | 386 ft. | 344 ft. | 235 ft. |
| Calcium sulphate..... | 0.57 | 0.5860 | 0.8307 | 0.5150 | 0.55 | 0.5446 |
| Calcium chloride..... | 0.09 | 0.0907 | 0.1851 | 0.1950 | 0.12 | 0.0926 |
| Magnesium chloride... | 0.15 | 0.1413 | 0.1717 | 0.1380 | 0.17 | 0.1609 |
| Salt ..... | 15.85 | 17.4840 | 17.1222 | 18.2000 | 17.97 | 14.9009 |
| Total saline matter .... | 16.66 | 18.3020 | 18.0097 | 19.0480 | 18.81 | 18.6990 |
| Water ..... | 83.34 | 81.5407 | 81.9903 | 80.9520 | 81.19 | 84.3010 |

### *The Grainer Process*

The grainer or Michigan process is, like the "kettle method," a purely American invention and consists in passing live or exhaust steam through a set of iron pipes



Neg. by I. P. Bishop.

GRAINER SALT. ATLANTIC SALT CO'S WORKS, WARSAW, N. Y.

immersed in long shallow wooden or iron vats. These vats rest on a strong wooden frame. They are from 100 to 150 feet long usually 12 feet wide and from 20 to 24 inches deep; provided with 4 to 6 steam pipes having a diameter of 4 to 5 inches and hung on pendants 4 to 6 inches above the bottom of the vats. These pipes are within a few feet of the same length as the grainer, and so arranged that the salt can be conveniently removed towards the outer side of the grainer. Over the top of the grainer is a strong platform to receive the salt taken from it for proper drainage; this also supports the pendants holding the steam pipes in their position. In most of the grainer blocks the salt is removed from the grainers by attendants called "lifters." In others an ingenious device called a "raker" does this work, automatically moving the salt constantly from the front end of the grainer to the back where it drops into properly constructed "conveyors" which deposit it in the salt bins. Where no rakers are employed the salt is removed every 24 hours. The brine which is "settled" in exactly the same manner as that treated by the kettle and pan methods is allowed to run into the grainers at the front end in the same proportion as the water evaporates from the brine. The only attention required, when the salt is not "lifted" is to pay proper attention to the supply of brine and the regulation of the steam which is all attended by one man. In most work soft coal is used as a fuel under the boilers, that and the expense for the fireman being a considerable item in the grainer plant. To obtain the best effect in a grainer system, the temperature of the heated brine should be kept at or near the boiling point when no lifting or removal of salt is in progress. To do this we must first supply to the grainers an abundance of high pressure steam, and secondly the constant supply of brine required for the grainers while evaporation is going on must enter at a temperature but little lower than that of the brine in the grainer. For this purpose two large tanks, so-called settlers, are em-

ployed, which are usually as long and wide as the grainers but 6 feet deep and provided with 4 rows of steam pipes about 1 foot above the floor to heat the cold brine drawn into them from the outside cisterns as required. Although the 6 rows of steam pipes in the grainer have an entire length of from 550 to 750 feet (suspended in the brine 4 to 6 inches above the bottom of the grainer and with 8 to 10 inches of brine above them) and a heating surface of from 700 to 1000 square feet, a great deal of the steam supplied to them is not condensed, and therefore passes from the grainer pipes into the settler pipes (sometimes passing through a steam trap to separate the condensed water) to heat the brine of the settlers. Whenever there is a surplus of steam, for instance while the lifting of the salt from the grainers is going on, the direct steam is used for the same purpose. To produce the best quality of salt the pickle in the grainers must not become overcharged with calcium and magnesium chlorides, which can only be done by removing from time to time the inferior pickle. Since this pickle contains from 18 to 20 per cent of salt, too valuable to go to waste, it is discharged into a set of grainers on the ground floor of the building, called lower or divided grainers. They are placed either directly under the upper grainers, in which case they are but 8 feet wide with 4 steam pipes, or in some other convenient place. The pickle is heated in them by uncondensed steam and condensed water coming from the steam pipes in the settlers and upper grainers. The product of these lower or divided grainers in consequence of the low temperature at which the salt is made in them, is very coarse, often having an inferior color. The salt is removed from them at longer intervals — every 6 or 10 days according to circumstances and the remaining pickle is discharged as useless. The removal of the salt into the bins, etc. does not differ in any essential from what has been stated in regard to the other methods.

A. Posts or piles, 12 inches by 12 inches, 8 feet apart; length according to ground.

B. Longitudinal sills, 12 inches by 12 inches; length according to size of grainer.

C. Cross sills, 17 feet by 12 inches by 10 inches; 3 feet apart from center to center.

D. Bottom planks of grainer, 16 feet or 12 feet long, 12 inches wide, 4 inches thick.

E. Side-boards, 36 feet by 4 inches by 22 inches to 24 inches wide; held together by one-inch dowel-pins or water-stays and in position by the timbers F and wedges.

F. Longitudinal wedge timber, 10 inches by 6 inches; length according to length of grainer.

G. End-boards, 24 inches high if the side boards are 24 inches wide; 12 inches wide and 4 inches thick.

H. Ingripe timbers, 14 feet by 8 inches by 6 inches, with one 2 inches by 4 inches groove which is 12 feet long.

I. Upper cross-beam for holding platform and suspended steam-pipes, 12 feet 8 inches long, 8 inches thick and 14 inches wide, 8 feet apart.

J. Steam-pipes, six rows, 3 inches to 4 inches in diameter.

K. Platform planks, seven in number, 16 feet by 1 foot by 4 inches.

L. Iron pendants to hold the pipes.

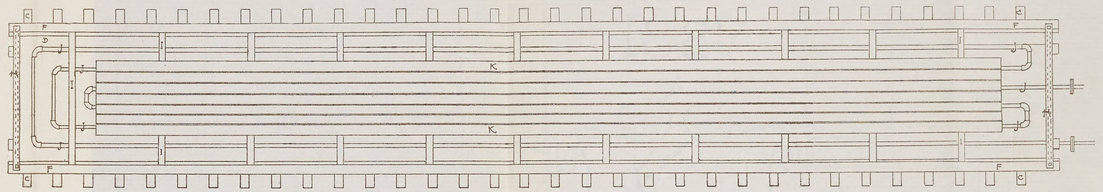
M. Pipe for conducting steam and condensed water to steam-trap A. From there the steam is conveyed to the pipes in the settlers and the hot water to the pipes in the dividend grainer.

N. Pipe for conducting brine from brine settlers to the grainers.

O. Pipe to convey discharged pickle from grainer to dividend grainer.

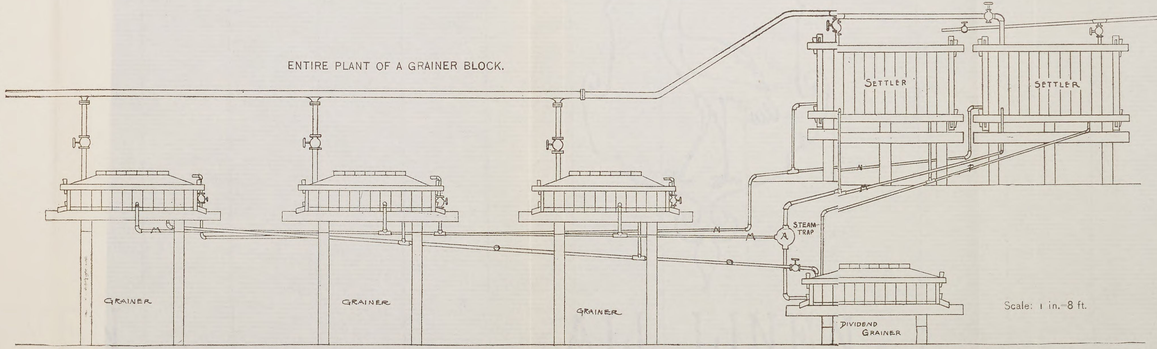
P. Pipe to bring steam and condensed water from settlers to dividend grainer.

TOP VIEW OF GRAINER.



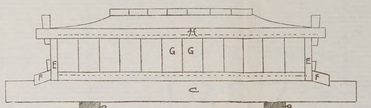
SCALE 1 in. = 8 ft

ENTIRE PLANT OF A GRAINER BLOCK.

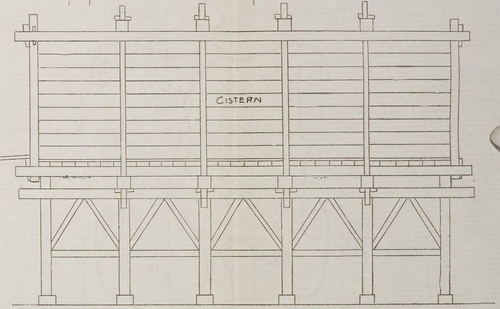


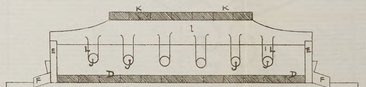

Scale: 1 in. = 8 ft.

F. E. Englehardt, del.



END ELEVATION OF GRAINER.
Scale: 1 in. = 4 ft.



TRANSVERSE SECTION OF GRAINER.
Scale: 1 in. = 4 ft.

### 4 VACUUM PAN EVAPORATION

or the evaporation of water from brines by steam, with a reduction of atmospheric pressure over the heated brine has been successfully introduced into two localities in this state, namely at the Duncan Salt Company's works, Silver Springs, Wyoming Co., and at Ludlowville, Tompkins Co. At the former place the process is carried on under the Duncan patents and at the latter under the Alexander Miller patents. Their product is a very handsome salt with a fine luster and very even grain, well adapted for table and dairy salt. The following generalized description of the former is furnished by Mr W. C. Clarke, E. M.

The vacuum process consists in evaporating the brine in a large vertical cylindrical iron vessel in which a vacuum is produced. By withdrawing the atmospheric pressure the boiling point of the brine is lowered whereby a quicker crystallization is produced and consequently a finer grain. In the pan are 17 or 18 groups of copper tubes, 20 tubes in each, the latter being parallel to each other and in one plane. At each end they are connected with an iron tube or heading at right angles to the copper tubes and in the same plane, through which steam from the outside connections is admitted to supply heat for evaporation. The copper tubes are surrounded by brine. The salt as it crystallizes collects in a large pipe at the bottom of the pan and when it is seen through a peep hole in the latter a valve is closed above the salt and it is dumped into a cylindrical screen revolving at about 600 revolutions per minute. The water is thrown against the screen and goes through by centrifugal force. The salt when dry, is ready for packing. This is the Worcester brand and a price much above that of the ordinary grainer salt is obtained for it.

### COMPARISON OF BRINES AND PROCESSES

As the brines used in the western part of the state — where the pan and grainer methods are exclusively employed —

are derived from the same salt deposits that supply Syracuse and which are situated in the Salina Group, they do not differ materially in their chemical composition, the main difference being rather one of concentration. The amount of calcium sulphate present in the brines is dependent, as at Syracuse, upon the quantity of calcium chloride contained in them. There is one remarkable fact to be recorded in this connection, namely, that while the brine from a new well usually contains calcium and magnesium chlorides in very small quantities, an increase of them is noticed after a time, especially when several wells very near to each other become connected under ground. The most plausible explanation which can be offered for this is that the shales above the rock-salt — almost all the wells in the western part of the state are sunk in the rock-salt — may be highly charged with these soluble chlorides and that when the salt surrounding the tubing of the well has been dissolved up to these overlying shales the chlorides of the alkaline earths find easy access to the brine. Mr I. P. Bishop states that he was informed by Mr C. Q. Freeman, vice president of the Retsof Mining Co., that a number of analyses of salt were made under his direction and that the samples taken from the top of a salt bed contained a greater proportion of deliquesent chlorides than those taken from the bottom. Whenever two or more wells belonging to the same company are found to be connected under ground the so-called forcing process is resorted to, which consists in pumping fresh water to the salt bed below by powerful pumps. Through one well (tubing) the water is forced down while the brine comes up through another. This may possibly have some influence on the overlying shales. As examples to show the quality of the western brines the following two analyses may serve:

# BRINE TABLE.

By F. E. Englehardt, Ph. D.

| Salometer, degrees. | Beaumé, degrees. | Specific gravity. | Per cent of salt. | Weight of a gallon of this brine in pounds of 7,000 grains each. | Pounds of salt in a gallon of brine of 231 cubic inches. | Gallons of brine required for a bushel of salt. | Pounds of water to be evaporated to produce a bushel of salt. | Pounds of coal required to produce a bushel of salt, one pound of coal evaporating six pounds of water. | Bushels of salt that can be made with a ton of coal of 2,000 pounds. |
|---|---|---|---|---|---|---|---|---|---|
| 1..... | .26 | 1.002 | .265 | 8.347 | .022 | 2,531.45 | 21,076.07 | 3,512.67 | .569 |
| 2..... | .52 | 1.003 | .530 | 8.356 | .044 | 1,264.47 | 10,510.03 | 1,751.67 | 1.141 |
| 3..... | .78 | 1.005 | .795 | 8.372 | .066 | 841.30 | 6,988.02 | 1,164.67 | 1.717 |
| 4..... | 1.04 | 1.007 | 1.060 | 8.389 | .088 | 629.72 | 5,227.03 | 871.17 | 2.295 |
| 5..... | 1.30 | 1.009 | 1.325 | 8.406 | .111 | 502.77 | 4,170.41 | 695.06 | 2.877 |
| 6..... | 1.56 | 1.010 | 1.590 | 8.414 | .133 | 418.56 | 3,466.01 | 577.66 | 3.462 |
| 7..... | 1.82 | 1.012 | 1.855 | 8.431 | .156 | 358.06 | 2,962.87 | 493.81 | 4.050 |
| 8..... | 2.08 | 1.014 | 2.120 | 8.447 | .179 | 312.68 | 2,585.50 | 430.91 | 4.641 |
| 9..... | 2.34 | 1.016 | 2.385 | 8.464 | .201 | 277.39 | 2,292.00 | 382.00 | 5.235 |
| 10..... | 2.60 | 1.017 | 2.650 | 8.472 | .224 | 249.41 | 2,057.20 | 342.86 | 5.833 |
| 11..... | 2.86 | 1.019 | 2.915 | 8.489 | .247 | 226.29 | 1,865.09 | 310.84 | 6.434 |
| 12..... | 3.12 | 1.021 | 3.180 | 8.506 | .270 | 207.02 | 1,705.00 | 284.16 | 7.038 |
| 13..... | 3.38 | 1.023 | 3.445 | 8.522 | .293 | 190.72 | 1,569.54 | 261.59 | 7.645 |
| 14..... | 3.64 | 1.025 | 3.710 | 8.539 | .316 | 176.76 | 1,453.43 | 242.23 | 8.256 |
| 15..... | 3.90 | 1.026 | 4.975 | 8.547 | .339 | 164.81 | 1,852.80 | 225.46 | 8.870 |
| 16..... | 4.16 | 1.028 | 4.240 | 8.564 | .364 | 154.21 | 1,264.75 | 210.79 | 9.488 |
| 17..... | 4.42 | 1.030 | 4.505 | 8.581 | .386 | 144.86 | 1,187.06 | 197.84 | 10.108 |
| 18..... | 4.68 | 1.032 | 4.770 | 8.597 | .410 | 136.54 | 1,118.00 | 186.33 | 10.733 |
| 19..... | 4.94 | 1.034 | 5.035 | 8.614 | .433 | 129.11 | 1,056.21 | 176.03 | 11.361 |
| 20..... | 5.20 | 1.035 | 5.300 | 8.622 | .457 | 122.54 | 1,000.60 | 176.76 | 11.992 |
| 21..... | 5.46 | 1.037 | 5.565 | 8.639 | .480 | 116.47 | 950.28 | 158.38 | 12.627 |
| 22..... | 5.72 | 1.039 | 5.830 | 8.656 | .504 | 110.96 | 904.54 | 150.75 | 13.266 |
| 23..... | 5.98 | 1.041 | 6.095 | 8.672 | .528 | 105.93 | 862.78 | 143.79 | 13.908 |
| 24..... | 6.24 | 1.043 | 6.360 | 8.689 | .552 | 101.33 | 824.50 | 137.41 | 14.554 |
| 25..... | 6.50 | 1.045 | 6.625 | 8.706 | .576 | 97.09 | 789.28 | 131.54 | 15.202 |
| 26..... | 6.76 | 1.046 | 6.890 | 8.714 | .600 | 93.26 | 756.77 | 126.12 | 15.856 |
| 27..... | 7.02 | 1.048 | 7.155 | 8.731 | .624 | 89.64 | 726.66 | 121.11 | 16.513 |
| 28..... | 7.28 | 1.050 | 7.420 | 8.747 | .649 | 86.27 | 698.71 | 116.45 | 17.173 |
| 29..... | 7.54 | 1.052 | 7.685 | 8.764 | .673 | 83.14 | 672.69 | 112.11 | 17.838 |
| 30..... | 7.80 | 1.054 | 7.950 | 8.781 | .698 | 80.21 | 648.40 | 108.06 | 18.507 |
| 31..... | 8.06 | 1.056 | 8.215 | 8.797 | .722 | 77.48 | 625.67 | 104.27 | 19.179 |
| 32..... | 8.32 | 1.058 | 8.480 | 8.814 | .747 | 74.92 | 604.37 | 100.72 | 19.855 |
| 33..... | 8.58 | 1.059 | 8.745 | 8.822 | .771 | 72.58 | 584.36 | 97.39 | 20.535 |
| 34..... | 8.84 | 1.061 | 9.010 | 8.839 | .796 | 70.31 | 565.53 | 94.25 | 21.218 |
| 35..... | 9.10 | 1.063 | 9.275 | 8.856 | .821 | 68.17 | 547.77 | 91.29 | 21.906 |
| 36..... | 9.36 | 1.065 | 9.540 | 8.872 | .846 | 66.15 | 531.00 | 88.50 | 22.598 |
| 37..... | 9.62 | 1.067 | 9.805 | 8.889 | .871 | 64.24 | 515.13 | 85.85 | 23.294 |
| 38..... | 9.88 | 1.069 | 10.070 | 8.905 | .896 | 62.44 | 500.10 | 83.35 | 23.983 |
| 39..... | 10.14 | 1.071 | 10.335 | 8.922 | .922 | 60.72 | 485.84 | 80.97 | 24.699 |
| 40..... | 10.40 | 1.073 | 10.600 | 8.939 | .947 | 59.09 | 472.30 | 78.71 | 25.407 |
| 41..... | 10 66 | 1.075 | 10.865 | 8.925 | .973 | 57.54 | 459.41 | 76.56 | 26.120 |
| 42..... | 10.92 | 1.077 | 11.130 | 8.972 | .998 | 56.07 | 447.14 | 74.52 | 26.837 |
| 43..... | 11.18 | 1.079 | 11.395 | 8.989 | 1.024 | 54.66 | 435.44 | 72.57 | 27.558 |
| 44..... | 11.44 | 1.081 | 11.660 | 9.005 | 1.050 | 53.32 | 424.27 | 70.71 | 28.283 |
| 45..... | 11.70 | 1.083 | 11.925 | 9.022 | 1.075 | 52.04 | 413.60 | 68.93 | 29.013 |
| 46..... | 11.96 | 1.085 | 12.190 | 9.039 | 1.101 | 50.82 | 403.39 | 67.23 | 29.747 |
| 47..... | 12.22 | 1.087 | 12.455 | 9.055 | 1.127 | 49.64 | 393.61 | 65.60 | 30.486 |
| 48..... | 12.48 | 1.089 | 12.720 | 9.072 | 1.154 | 48.52 | 384.25 | 64.04 | 31.229 |
| 49..... | 12.74 | 1.091 | 12.985 | 9.089 | 1.180 | 47.44 | 375.26 | 62.54 | 31.977 |
| 50..... | 13.00 | 1.093 | 13.250 | 9.105 | 1.206 | 46.41 | 366.64 | 61.10 | 32.729 |
| 51..... | 13.26 | 1.095 | 13.515 | 9.122 | 1.232 | 45.42 | 358.34 | 59.72 | 33.487 |
| 52..... | 13.52 | 1.097 | 13.780 | 9.139 | 1.259 | 44.46 | 350.38 | 58.39 | 34.247 |
| 53..... | 13.78 | 1.100 | 14.045 | 9.164 | 1.287 | 43.50 | 342.71 | 57.11 | 35.015 |
| 54..... | 14.04 | 1.102 | 14.310 | 9.180 | 1.313 | 42.62 | 335.35 | 55.89 | 35.783 |
| 55..... | 14.30 | 1.104 | 14.575 | 9.197 | 1.340 | 41.77 | 328.21 | 54.70 | 36.560 |
| 56..... | 14.56 | 1.106 | 14.840 | 9.214 | 1.367 | 40.95 | 321.35 | 53.55 | 37.341 |
| 57..... | 14.82 | 1.108 | 15.105 | 9.230 | 1.394 | 40.16 | 314.74 | 52.45 | 38.126 |
| 58..... | 15.08 | 1.110 | 15.370 | 9.247 | 1.421 | 39.39 | 308.34 | 51.39 | 38.917 |
| 59..... | 15.34 | 1.111 | 15.635 | 9.264 | 1.448 | 38.66 | 302.17 | 50.36 | 39.712 |
| 60..... | 15.60 | 1.114 | 15.900 | 9.280 | 1.475 | 37.94 | 296.21 | 49.36 | 40.512 |
| 61..... | 15.86 | 1.116 | 16.165 | 9.297 | 1.502 | 37.26 | 290.43 | 48.40 | 41.317 |
| 62..... | 16.12 | 1.118 | 16.430 | 9.314 | 1.530 | 36.59 | 284.84 | 47.47 | 42.129 |
| 63..... | 16.38 | 1.121 | 16.695 | 9.339 | 1.559 | 35.91 | 279.42 | 46.57 | 42.945 |
| 64..... | 16.64 | 1.123 | 16.960 | 9.355 | 1.586 | 35.29 | 274.18 | 45.69 | 43.765 |
| 65..... | 16.90 | 1.125 | 17.225 | 9.372 | 1.614 | 34.68 | 269.10 | 44.85 | 44.591 |
| 66..... | 17.16 | 1.127 | 17.490 | 9.389 | 1.642 | 34.10 | 264.18 | 44.03 | 45.423 |
| 67..... | 17.42 | 1.129 | 17.755 | 9.405 | 1.670 | 33.53 | 259.40 | 43.23 | 46.260 |
| 68..... | 17.68 | 1.131 | 18.020 | 9.422 | 1.697 | 32.98 | 254.76 | 42.46 | 47.102 |
| 69..... | 17.94 | 1.133 | 18.285 | 9.439 | 1.725 | 32.44 | 250.26 | 41.71 | 47.949 |
| 70..... | 18.20 | 1.136 | 18.550 | 9.464 | 1.755 | 31.89 | 245.88 | 40.98 | 48.802 |
| 71..... | 18.46 | 1.138 | 18.815 | 9.480 | 1.783 | 31.39 | 241.63 | 40.27 | 49.662 |
| 72..... | 18.72 | 1.140 | 19.080 | 9.497 | 1.812 | 30.90 | 237.50 | 39.58 | 50.526 |
| 73..... | 18.98 | 1.142 | 19.345 | 9.514 | 1.840 | 30.42 | 233.47 | 38.91 | 57.397 |
| 74..... | 19.24 | 1.144 | 19.610 | 9.530 | 1.868 | 29.96 | 229.56 | 38.26 | 52.272 |
| 75..... | 19.50 | 1.147 | 19.875 | 9.555 | 1.899 | 29.48 | 225.76 | 37.62 | 53.153 |
| 76..... | 19.76 | 1.149 | 20.140 | 9.572 | 1.927 | 29.04 | 222.05 | 37.00 | 54.041 |
| 77..... | 20.02 | 1.151 | 20.405 | 9.589 | 1.956 | 28.62 | 218.44 | 36.40 | 54.934 |
| 78..... | 20.28 | 1.154 | 20.670 | 9.614 | 1.987 | 28.17 | 214.92 | 35.82 | 55.834 |
| 79..... | 20.54 | 1.156 | 20.935 | 9.630 | 2.016 | 27.77 | 211.49 | 35.24 | 56.739 |
| 80..... | 20.80 | 1.158 | 21.200 | 9.647 | 2.045 | 27.38 | 208.14 | 34.69 | 57.650 |
| 81..... | 21.06 | 1.160 | 21.465 | 9.664 | 2.074 | 26.99 | 204.88 | 34.14 | 58.568 |
| 82..... | 21.32 | 1.163 | 21.730 | 9.689 | 2.105 | 26.59 | 201.70 | 33.61 | 59.471 |
| 83..... | 21.58 | 1.165 | 21.995 | 9.705 | 2.134 | 26.23 | 198.60 | 33.10 | 60.421 |
| 84..... | 21.84 | 1.167 | 22.260 | 9.722 | 2.164 | 25.87 | 195.57 | 32.59 | 61.359 |
| 85..... | 22.10 | 1.170 | 22.525 | 9.747 | 2.195 | 25.50 | 192.61 | 32.10 | 62.301 |
| 86..... | 22.36 | 1.172 | 22.790 | 9.764 | 2.225 | 25.16 | 189.72 | 31.62 | 63.250 |
| 87..... | 22.62 | 1.175 | 23.055 | 9.789 | 2.256 | 24.81 | 186.89 | 31.14 | 64.206 |
| 88..... | 22.88 | 1.177 | 23.320 | 9.805 | 2.286 | 24.48 | 184.13 | 30.68 | 65.168 |
| 89..... | 23.14 | 1.179 | 23.585 | 9.822 | 2.316 | 24.17 | 181.44 | 30.24 | 66.137 |
| 90..... | 23.40 | 1.182 | 23.850 | 9.847 | 2.348 | 23.84 | 178.80 | 29.80 | 67.113 |
| 91..... | 23.66 | 1.184 | 24.115 | 9.864 | 2.378 | 23.54 | 176.22 | 29.37 | 68.096 |
| 92..... | 23.92 | 1.186 | 24.380 | 9.880 | 2.408 | 23.24 | 173.69 | 28.94 | 69.085 |
| 93..... | 24.18 | 1.189 | 24.645 | 9.905 | 2.441 | 22.93 | 171.22 | 28.53 | 70.086 |
| 94..... | 24.44 | 1.191 | 24.910 | 9.922 | 2.471 | 22.65 | 168.80 | 28.13 | 71.086 |
| 95..... | 24.70 | 1.194 | 25.175 | 9.947 | 2.504 | 22.36 | 166.44 | 27.73 | 72.105 |
| 96..... | 24.96 | 1.196 | 25.440 | 9.964 | 2.534 | 22.09 | 164.12 | 27.35 | 73.114 |
| 97..... | 25.22 | 1.198 | 25.705 | 9.980 | 2.565 | 21.82 | 161.85 | 26.97 | 74.140 |
| 98..... | 25.48 | 1.201 | 25.970 | 10.005 | 2.598 | 21.55 | 159.63 | 26.60 | 75.172 |
| 99..... | 25.74 | 1.203 | 26.235 | 10.022 | 2.629 | 21.29 | 157.45 | 26.24 | 76.212 |
| 100..... | 26.00 | 1.205 | 26.500 | 10.039 | 2.660 | 21.04 | 155.32 | 25.88 | 77.259 |

This brine table was constructed on the assumption, that a pure saturated solution of salt has a specific gravity of 1.205 at 60° Fahrenheit and contains 26.5 per cent of pure salt. The salometer introduced in most all the salt works of the state of New York is an areometer with a scale divided into 100 parts or degrees. The density of distilled water at 60° Fahrenheit is indicated by 0° and that of saturated brine by 100°. With a reduction of temperature the brine becomes specifically heavier, hence the salometer will not sink so low, while when the temperature of the brine is above 60° Fahrenheit and therefore specifically lighter it will sink lower. It is usually sufficient for all practical purposes to add or deduct one degree to or from the reading for every ten degrees the temperature is above or below the normal.

| | Wyoming Valley Brine. | Genesee Valley Brine. |
|---|---|---|
| Specific gravity | 1.20446 | 1.1891 |
| Calcium sulphate | 0.4430 | 0.3780 |
| Calcium chloride | 0.1380 | 0.1913 |
| Magnesium chloride | 0.0530 | 0.1897 |
| Pure salt | 25.7110 | 24.1221 |
| Water | 73.6550 | 75.1189 |
| | 99.9500 | 100.0000 |

The following two analyses of the same brines after the lapse of considerable time exemplify the above statement:

| | Wyoming Valley Brine | | Genesee Valley Brine | |
|---|---|---|---|---|
| Specific gravity | 1.1924 | | 1.20446 | |
| Calcium sulphate | 0.433 | per cent. | 0.407 | per cent. |
| Calcium chloride | 0.069 | " | 0.140 | " |
| Magnesium chloride | 0.143 | " | 0.322 | " |
| Pure salt | 25.008 | " | 25.564 | " |
| Water | 74.347 | " | 73.567 | " |
| | 100.000 | | 100.000 | |

Before considering the special advantages of the various methods it is but proper to offer a few general remarks on evaporation. Water when it comes in contact with air yields vapor and the amount of the latter is always dependent on the temperature of the former. The formation of vapor always takes place on the surface of the water so long as the boiling point is not reached. If spontaneous or assisted by artificial means and it can only occur with the assistance of heat, and if there is not a direct outside source for this heat it is extracted either from the parts surrounding the water or from the latter, thereby reducing its temperature.

When the formation of vapor takes place, not only on the surface of the liquid but also within it at the bottom and sides of the vessel exposed to a source of heat, the liquid boils. In evaporation the formation of vapor takes place on the surface; in boiling within the liquid. The former is a slow, the latter a quick method of evaporation. When water is heated in an open vessel to its boiling point, its

temperature becomes stationary, and while a more intense heat increases the rapidity of evaporation it can not raise the temperature, therefore the quicker we can supply the amount of heat required for the evaporation of a given quantity of water, the shorter must be the time in which it can be accomplished. A given quantity of water, exposed in two vessels, in one of which it is but 1 inch high and in the other 10 inches, to the same amount of heat on their heating surfaces, will evaporate in different spaces of time. The water in the vessel with the larger heating surface evaporates in one-tenth of the time of that in the other vessel, since the former has ten times more heating surface, and therefore transfers the heat ten times faster, hence we may say; that the quantity of water that can be evaporated in a given time and at a given temperature is directly proportional to the area of the heating surface.

We assumed before that we supplied both vessels with the same amount of heat, could we raise the temperature under the vessel with the smaller heating surface, so as to impart to the water it contains as much heat as to our large vessel in exactly the same time, the result would be the same. Two vessels with equal heating surfaces and containing equal quantities of water, will show unequal results if one be heated more strongly than the other, the one more strongly heated evaporating more water in the same given time. With equal heating surfaces the amount of water evaporated in a given time is directly proportional to the temperature of the heated surfaces. The temperature at which water boils under ordinary circumstances at sea level is 212° Fahrenheit, but at high elevations where the air is lighter it boils at a lower temperature, and in deep mines at a higher temperature caused by the increased pressure of the air, hence it follows that the boiling temperature of water is dependent on the pressure of the air resting on the boiling liquid.

The fact is well known that water in an open vessel un-

der an air pump where a vacuum is maintained, boils near its freezing point. The heat required for it is taken by the water from the surroundings namely, the air pump. But to do this requires almost a perfect vacuum which we can not produce in practice, but we can readily boil water in a vacuum pan at 135° Fahr. If the steam employed for this purpose is 230° Fahr. then the difference between 135° Fahr. at which the water boils and the temperature of the steam supplied is 95° and we can produce a very rapid evaporation provided we have sufficient heating surface at our disposal. Hence steam at any temperature will cause the evaporation of a liquid, of which the boiling point is below the temperature of the steam.

From the description given of the methods employed in the manufacture of salt, it is evident that a perfect comparison in regard to the practical results is a most difficult problem, since the quality of the brine and the fuel will often vary from week to week in the same work. Taking therefore the average results for a season or a year we find that with proper attention, good condition of the works and fuel, a kettle-block can produce 45 bushels (56 pounds each) of salt with a brine of 67° Salometer *per ton* of anthracite dust or, one pound of fuel evaporates 5.83 pounds of water, while a pan under the same conditions but with a brine of 96° Salometer yields 73 bushels of salt, hence a pound of fuel evaporates 6 pounds of water. The results with the upper (direct) grainer together with that of the lower or dividend grainer using a brine of 96° Salometer is 70 bushels, corresponding to an evaporation of 5.74 pounds of water per pound of fuel. These results are very low indeed as compared to those obtained in good steam boilers, but it must be taken into consideration that the conditions in both cases are very different. The expense for labor is greatest in the kettle method, next comes the pan and finally the grainer method. The wear and tear is very heavy in all salt works but especially in kettle and pan block. Allowing a

kettle or pan block to lie idle for a year, almost ruins it, hence it is often cheaper to make salt for a season without profit, than to leave the works to themselves.

The main difficulty with which the salt manufacturers of our state have to contend is the calcium sulphate or, as it is called by them, and very properly, the plaster. In fact it is this impurity, as I stated previously, which causes the interruption of the process and the laborious cleaning out, whether we use the kettle, the pan, the grainer or the vacuum pan. It not only entails a great loss of heat in consequence of its low conductivity, but it also causes the overheating of the metal exposed to direct fire wherever this is employed. While this is of little consequence in regard to kettles, it is of great importance in regard to salt pans, since their bottoms have usually only a thickness of $\frac{1}{4}$ to $\frac{3}{8}$ inches, and wherever they become coated with this plaster, especially above and near the fires, overheating and unequal expansion of the iron results they warp and become uneven. It can easily be understood, that a proper removal of the salt from an uneven pan bottom is very difficult and where the warping is bad it is impossible. In consequence the salt bakes on, is of inferior color, and the pan becomes leaky and has to be repaired, which involves often not only heavy expense but loss of time. The heating of the brine as much as possible in the back pan and the raising of its temperature near to the boiling point, in the second section of the front pan before passing it into the front section are of great service in the removal of all the calcium sulphate that can be removed under ordinary circumstances.

Suggestions and experiments have been made to overcome this difficulty, involving the expenditure of great sums of money, but without any practical results as far as mechanical means are concerned.

The chemical means proposed, especially the use of sodium carbonate and trisodium phosphate for the removal of the calcium sulphate from the brine, would involve not

only a much heavier expense than the present price of ordinary salt will warrant, but by their use we would substitute sodium sulphate for calcium sulphate, which when present in the salt would be more objectionable than the latter. Moreover the decomposition of the calcium sulphate by sodium carbonate or trisodium phosphate would involve at the same time the decomposition of the calcium and magnesium chlorides into calcium and magnesium carbonates or phosphates, thus bringing the expense for these chemicals up to such a high figure per bushel of salt that their use is out of the question.

The other impurities found in the salt brines of the State of New York which have an important bearing on the manufactured product are the very soluble and deliquescent calcium and magnesium chlorides. Although only present in the brines in small quantities, namely from about 0.15 to 0.75 per cent, they accumulate in the pickle or bitter water as the salt is removed, no matter by what method we obtain the salt. Thus in the solar salt fields they accumulate (gradually) in the pickle to such an extent, as previously stated, that evaporation practically ceases, when such a pickle contains only about 8 per cent of salt but nearly 21 per cent of the chlorides. In properly attended salt works the pickle is removed before such an accumulation of the calcium and magnesium chlorides takes place. It is usually discharged whenever it becomes necessary to scale the kettles, pans or grainer pipes, though in some grainer works a certain portion of the pickle is removed every two or three days from the upper into the lower grainers. When a certain ratio exists between the salt and these chlorides (especially the magnesium chloride) in a pickle evaporated by artificial heat a thin film is formed over the heated but not boiling liquid, which greatly retards evaporation and forms again as soon as removed. This is an indication that the chlorides of the alkaline earths should be removed.

The accompanying list of the salt manufacturers of New York State gives an idea of the magnitude of this industry, but it is not possible to obtain any accurate statistics concerning the amount and value of the total product of salt in New York. This is estimated for 1892 by Dr. F. E. Englehardt as follows:

| | |
|---|---|
| Western part of the state | 11,500,000 bus. |
| Mined salt | 7,000,000 " |
| Onondaga reservation | 4,406,000 " |
| Grand total | 22,906,000 " |

Value per bushel between $7\frac{1}{2}$ to 8 cents, dairy salt somewhat higher.

NAMES AND LOCALITIES OF SALT MANUFACTURERS IN NEW YORK

| Company | Location | Process | No. of wells |
|---|---|---|---|
| LeRoy Salt Co | LeRoy, Genesee Co., N. Y. | Grainer | 9 |
| Lehigh Salt and Mining Co | Lehigh, Genesee Co., N. Y | Mining | .. |
| Pavilion Salt Co | Pavilion, Genesee Co., N. Y | Pans & grainers. | 2 |
| Pearl Salt Co | Pearl Creek, Wyoming Co., N. Y | Grainer | 2 |
| Crystal Salt Co | Salt Vale, Wyoming Co., N. Y | Large pans | 2 |
| Miller Salt Co | Warsaw, Wyoming Co., N. Y | Kettles with steam jackets. | 2 |
| Atlantic Salt Co | " " " | Kettles with steam jackets. | 1 |
| Warsaw Salt Co | " " " | Pan | 6 |
| Gouinlock & Humphrey | " " " | Pan | 4 |
| Hawley Salt Co | " " " | Pan | 3 |
| Empire Salt Co | " " " | Grainer | 4 |
| Bradley Salt Co | " " " | Grainer | 5 |
| Alex. Kerr Bros. & Co | Rock Glen, Wyoming Co., N. Y | Grainer and pan. | 7 |
| Perry Salt Co | Perry, Wyoming Co., N. Y | Grainer | 2 |
| Duncan Salt Co | Silver Springs, Wyoming Co | Vacuum pan and grainer | 6 |
| Castile Salt Co | Castile, Wyoming Co., N. Y | Pan | 2 |
| Gainesville Salt Co | Gainesville Creek, Wyoming Co., N. Y. | * | 1 |
| Bliss Salt Co | Bliss, Wyoming Co., N. Y | † | 1 |
| York Salt Co | York, Livingston Co., N. Y | Grainer | 2 |
| Livingston Salt Co | Piffard, Livingston Co., N. Y | Grainer | 2 |
| Genesee Salt Co | " " " | Pan | 5 |
| Phœnix Salt Co | Cuylerville, Livingston Co., N. Y | Small pans | 1 |
| Lackawanna Salt Co | Mt. Morris, Livingston Co., N. Y | Grainer | 2 |
| Royal Salt Co | " " " | Grainer | 3 |
| Cayuga Lake Salt Co | Ludlowville, Tompkins Co., N. Y | Grainers & pans. | 1 |
| Greigsville Salt and Mining Co | Greigsville, Livingston Co., N. Y | Mining | .. |
| Livonia Salt and Mining Co | Livonia, Livingston Co., N. Y | " | .. |
| Retsof Mining Co | Retsof, Livingston Co., N. Y | " | .. |

* Process in use not ascertained.

† Works not yet in operation.

TABULAR STATEMENT OF THE NUMBER OF BUSHELS OF SALT MADE AT THE ONONDAGA SALT SPRINGS SINCE JUNE 20, 1797, WHICH IS THE DATE OF THE FIRST LEASES IN LOTS:

| DATE. | Solar. | Fine. | Aggregate bushels. | Superintendent. |
|---|---|---|---|---|
| 1797 | ..... | 25,474 | 25,474 | William Stevens. |
| 1798 | ..... | 59,928 | 59,928 | William Stevens. |
| 1799 | ..... | 42,704 | 42,704 | William Stevens. |
| 1800 | ..... | 50,000 | 50,000 | William Stevens. |
| 1801 | ..... | 62,000 | 62,000 | Sheldon Logan. |
| 1802 | ..... | 75,000 | 75,000 | Asa Danforth. |
| 1803 | ..... | 90,000 | 90,000 | Asa Danforth. |
| 1804 | ..... | 100,000 | 100,000 | Asa Danforth. |
| 1805 | ..... | 154,071 | 154,071 | William Kirkpatrick. |
| 1806 | ..... | 122,577 | 122,577 | William Kirkpatrick. |
| 1807 | ..... | 175,448 | 175,448 | P. H. Ransom. |
| 1808 | ..... | 319,618 | 319,618 | Nathan Stewart. |
| 1809 | ..... | 128,282 | 128,282 | John Richardson. |
| 1810 | ..... | 452,050 | 452,050 | William Kirkpatrick. |
| 1811 | ..... | 200,000 | 200,000 | William Kirkpatrick. |
| 1812 | ..... | 221,011 | 221,011 | William Kirkpatrick. |
| 1813 | ..... | 226,000 | 226,000 | William Kirkpatrick. |
| 1814 | ..... | 295,000 | 295,000 | William Kirkpatrick. |
| 1815 | ..... | 322,058 | 322,058 | William Kirkpatrick. |
| 1816 | ..... | 348,655 | 348,655 | William Kirkpatrick. |
| 1817 | ..... | 408,655 | 408,655 | William Kirkpatrick. |
| 1818 | ..... | 406,540 | 406,540 | William Kirkpatrick. |
| 1819 | ..... | 548,374 | 548,374 | William Kirkpatrick. |
| 1820 | ..... | 458,329 | 458,329 | William Kirkpatrick. |
| 1821 | ..... | 526,049 | 526,049 | William Kirkpatrick. |
| 1822 | ..... | 481,562 | 481,562 | William Kirkpatrick. |
| 1823 | ..... | 726,988 | 726,988 | William Kirkpatrick. |
| 1824 | ..... | 816,634 | 816,634 | William Kirkpatrick. |
| 1825 | ..... | 757,203 | 757,203 | William Kirkpatrick. |
| 1826 | ..... | 811,023 | 811,023 | William Kirkpatrick. |
| 1827 | ..... | 983,410 | 983,410 | William Kirkpatrick. |
| 1828 | ..... | 1,160,888 | 1,160,888 | William Kirkpatrick. |
| 1829 | ..... | 1,129,280 | 1,129,280 | William Kirkpatrick. |
| 1830 | ..... | 1,435,446 | 1,435,446 | William Kirkpatrick. |
| 1831 | ..... | 1,514,037 | 1,514,037 | N. H. Earll. |
| 1832 | ..... | 1,652,985 | 1,652,985 | N. H. Earll. |
| 1833 | ..... | 1,838,648 | 1,838,648 | N. H. Earll. |
| 1834 | ..... | 1,943,252 | 1,943,252 | N. H. Earll. |
| 1835 | ..... | 1,209,867 | 1,209,867 | N. H. Earll. |
| 1836 | ..... | 1,912,858 | 1,912,858 | Rial Wright. |
| 1837 | ..... | 2,167,287 | 2,167,287 | Rial Wright. |
| 1838 | ..... | 2,575,033 | 2,575,033 | Rial Wright. |
| 1839 | ..... | 2,864,718 | 2,864,718 | Rial Wright. |
| 1840 | ..... | 2,621,305 | 2,621,305 | Thomas Spencer. |
| 1841 | 220,247 | 3,120,230 | 3,340,767 | Thomas Spencer. |
| 1842 | 163,021 | 2,128,882 | 2,293,908 | Thomas Spencer. |
| 1843 | 318,105 | 2,809,395 | 3,127,500 | Rial Wright. |
| 1844 | 332,418 | 2,968,136 | 4,300,554 | Rial Wright. |
| 1845 | 353,455 | 3,408,903 | 3,762,358 | Enoch Marks. |
| 1846 | 331,705 | 3,507,146 | 3,838,851 | Enoch Marks. |
| 1847 | 262,879 | 3,688,476 | 3,951,355 | Enoch Marks. |
| 1848 | 342,497 | 3,994,629 | 4,737,126 | Robert Gere. |
| 1849 | 377,735 | 4,705,824 | 5,083,569 | Robert Gere. |
| 1850 | 374,732 | 3,894,187 | 4,268,919 | Robert Gere. |
| 1851 | 378,967 | 4,235,150 | 4,614,117 | Robert Gere. |
| 1852 | 633,595 | 4,288,938 | 4,922,533 | Hervey Rhodes. |
| 1853 | 577,947 | 4,826,577 | 5,404,524 | Hervey Rhodes. |
| 1854 | 734,474 | 5,068,873 | 5,803,347 | Hervey Rhodes. |
| 1855 | 498,124 | 5,584,761 | 6,082,885 | Vivus W. Smith. |
| 1856 | 709,391 | 5,257,419 | 5,996,810 | Vivus W. Smith. |
| 1857 | 481,280 | 3,830,846 | 4,312,126 | Vivus W. Smith. |
| 1858 | 1,514,554 | 5,518,665 | 7,033,391 | Vivus W. Smith. |
| 1859 | 1,345,022 | 5,549,250 | 6,894,271 | Vivus W. Smith. |
| 1860 | 1,452,565 | 4,130,682 | 5,593,247 | Vivus W. Smith. |
| 1861 | 1,884,697 | 5,315,549 | 7,200,391 | Vivus W. Smith. |
| 1862 | 1,983,022 | 7,070,852 | 9,053,874 | Vivus W. Smith. |
| 1863 | 1,437,656 | 6,504,727 | 7,842,383 | Vivus W. Smith. |
| 1864 | 1,971,122 | 5,407,712 | 7,378,884 | Vivus W. Smith. |
| 1865 | 1,886,760 | 4,499,170 | 6,385,930 | George Geddes. |
| 1866 | 1,978,883 | 5,180,320 | 7,158,503 | George Geddes. |
| 1867 | 2,271,892 | 5,323,673 | 7,595,565 | George Geddes. |
| 1868 | 2,027,490 | 6,639,126 | 8,666,616 | George Geddes. |
| 1869 | 1,857,942 | 6,804,285 | 8,662,237 | George Geddes. |
| 1870 | 2,847,691 | 6,260,422 | 8,748,115 | George Geddes. |
| 1871 | 2,464,404 | 5,910,492 | 8,374,956 | John M. Strong. |
| 1872 | 1,882,604 | 6,048,321 | 7,930,925 | John M. Strong. |
| 1873 | 1,691,359 | 5,768,998 | 7,460,357 | John M. Strong. |
| 1874 | 1,667,368 | 4,361,932 | 6,029,300 | A. C. Powell. |
| 1875 | 2,655,955 | 4,523,491 | 7,179,546 | A. C. Powell. |
| 1876 | 2,308,679 | 3,083,998 | 5,392,667 | A. C. Powell. |
| 1877 | 2,525,335 | 3,902,648 | 6,427,983 | A. C. Powell. |
| 1878 | 2,788,754 | 4,387,443 | 7,176,197 | A. C. Powell. |
| 1879 | 2,957,744 | 5,364,418 | 8,322,162 | A. C. Powell, eight months.<br>C. G. Hinkley, four months. |
| 1880 | 2,516,485 | 5,482,265 | 7,998,750 | N. Stanton Gere. |
| 1881 | 3,011,461 | 4,905,775 | 7,917,236 | N. Stanton Gere. |
| 1882 | 3,032,447 | 5,307,773 | 8,340,180 | N. Stanton Gere. |
| 1883 | 2,470,533 | 5,432,439 | 7,902,972 | P. J. Brummelkamp. |
| 1884 | 2,353,860 | 4,588,409 | 6,942,259 | P. J. Brummelkamp. |
| 1885 | 2,439,332 | 4,494,967 | 6,934,299 | P. J. Brummelkamp. |
| 1886 | 2,772,348 | 3,329,409 | 6,101,757 | P. J. Brummelkamp. |
| 1887 | 3,118,974 | 2,576,823 | 5,695,797 | P. J. Brummelkamp. |
| 1888 | 3,115,314 | 2,542,053 | 5,657,367 | P. J. Brummelkamp. |
| 1889 | 2,916,923 | 2,448,138 | 5,365,061 | P. J. Brummelkamp. |
| 1890 | 2,726,471 | 2,201,651 | 4,928,122 | P. J. Brummelkamp. |
| 1891 | 2,113,727 | 1,735,186 | 3,948,914 | P. J. Brummelkamp. |
| 1892 | 3,122,789 | 1,282,885 | 4,405,674 | P. J. Brummelkamp. |
| Total amount since 1797 | 85,852,095 | 270,570,483 | 356,422,095 | |

Or about 142½ million cubic feet (nearly ten millions tons of 2,000 pounds each).

This table gives the amount of salt inspected by the State officers for each year, but not the amount actually made, in other words the amount of salt sold in each year.

## SYRACUSE SALT MANUFACTURERS

*Fine Salt*

F. Beagle & Co.
L. Gleason
C. A. Stilwell
Edward Lynch
William J. Killian
Andrew Martin
Michael R. Hayes
James Salmon
A. L. Mason
Martin Salmon
H. H. Freeman
John Maloney
M. Prell
P. Prendergast

*Solar Salt*

Western Coarse Salt Co.
James M. Gere
Theo. L. Poole
Draper & Porter
W. B. Boyd
Turks Island Coarse Salt Co.
Geddes Coarse Salt Co.
W. & D. Kirkpatrick
Foster Ely
Union Coarse Salt Co.
Cape Cod Coarse Salt Co.
L. Stevens & Co.
Syracuse Solar Salt Co.
Empire Coarse Salt Co.
Salina Coarse Salt Co.
S. Jaquett & Co.
Salina Coarse and Fine Salt Co.
Robert Young
Thomas Gale
Highland Coarse Salt Co.
C. B. Murray
Phillip Corkings
John White & Co.
Salt Springs Solar Coarse Salt Co.

*Soaa Ash Manufacturers*

Solvay Process Co., Geddes, N. Y. Wells at Tully.

# THE GYPSUM INDUSTRY OF NEW YORK STATE

By William C. Clarke, E. M.

Gypsum is the sulphate of lime and contains lime 32.6%, sulphuric acid 46.5%, water 20.9%. Its specific gravity when pure varies between 2.314 and 2.328.

The crystallized variety is known as selenite. The pure mineral is $CaSO_4 + 2_2H_2O$. Oxides of iron and silica are also present. The crystalline variety occurs in the quarries in but small quantities. It has a pearly lustre and a cleavage similar to that of mica and splits into very thin plates. The pure massive mineral resembles marble in texture and color and is quarried under the name of alabaster.

When exposed to a heat of not over 260° F. gypsum loses its water of crystallization and if reduced to powder it has the property of recombining with water when mixed with it and forming a solid mass. This recombination does not take place if the material is overheated.

The geological occurrence of gypsum has already been described and its geographical distribution is shown on the accompanying map.

Selenite and anhydrite have been found in Niagara Co. near Lockport.

The gypsum occurs in beds of considerable regularity, plainly showing in places its original deposition from water. No evidence of gypsum can be found east of Hobokenville, Madison Co. Toward its eastern limit the gypsum is of a much darker and earthy type. The dark color of the gypsum is said to be due to the presence of carbonaceous matter and not to metallic oxides, but it is probable that

the whiter variety of the west will analyze much higher in pure gypsum than the darker and more earthy gypsum of the east end of the belt. It is noted in quarrying the mineral that the dark variety is not usually covered with much rock and can be found at a comparatively small depth by removing the overlying drift, while the white variety is quite generally heavily capped with rock, is found at a considerable depth, is not nearly as thick as the dark kind and is worked entirely underground. This is probably due to the inferior solubility of the earthy variety.

The following parties quarry gypsum in New York state:

| | | |
|---|---|---|
| Cyrus Warlock, | Perrysville, | Madison Co. |
| Irving Tuttle, | Hobokenville, | " |
| R. D. Buttons, | Cottons, | " |
| L. D. Sherman, | Marcellus Falls, | Onondaga Co |
| Lansing & Son, | Fayetteville, | " |
| W. W. Condee, | " | " |
| A. W. Edwards, | " | " |
| Richard Rod, | " | " |
| F. M. Severance, Mgr., | " | " |
| Robert Dunlop, | Jamesville, | " |
| Simon Reals, | " | " |
| A. E. Alvord, | Syracuse, | " |
| Cayuga Plaster Co., | Union Springs, | Cayuga Co. |
| A. D. Miller, | Phelps, | Ontario Co. |
| Ezra Grinnell, | Port Gibson, | " |
| Theodore Conover, | Victor, | " |
| Samuel Weeks, | Garbuttsville, | Monroe Co. |
| J. W. Garbutt, | " | " |
| Wheatland Land Plaster Co., | Mumford, | " |
| —— Olmstead, | Oakfield, | Genesee Co. |
| S. Gilmore, | Indian Falls, | " |

Of these the Cayuga Plaster Co. operates on the largest and most approved scale; their openings are the largest, their deposit is extensive and the work is conducted in

economical and sound business principles. The deposit controlled by Mr Severance at Fayetteville is the largest so far as actual thickness is concerned, and the same is nearly true of the Mr Lansing's adjoining bed. The gypsum of Mr Olmstead's quarry at Oakfield is the whitest and apparently the purest, closely followed by that operated by the Wheatland Land Plaster Co. The most westerly deposits are found at some depth and are worked underground, while in Ontario Co. and to the east the gypsum is all worked in open cuts.

## DESCRIPTION OF GYPSUM QUARRIES

The most extended operations in the quarrying of gypsum in New York are now being conducted by the Cayuga Plaster Co., whose offices are at Union Springs. The plant is on the Lehigh Valley R. R. at the junction of the Cayuga branch and the Auburn branch. The mills are near the tracks and shipping facilities are excellent. The beds have been worked more than 50 yrs. The work at present is being conducted on the S. E. dip of a roll or fold. The slate and crane rock are used for making and maintaining the roads of the quarry. The gypsum is covered by earth varying in thickness from a few feet to 20 or 25 ft. The gypsum is rarely covered with rock although in one old opening two or three feet of a water lime were visible. The dirt is "stripped" and removed to the dump heap, and the "plaster rock" is worked from projecting caps to the limestone below. The gypsum is drilled with ordinary jumper drills, the holes are fired with black powder and the blocks broken up by sledges. The material is carted in one horse carts and piled up in store houses near the mill $\frac{1}{8}$ of a mile distant, ready for grinding. The mill begins running in January and runs about 7 months now, although they have in the past worked continuously and even in double shift.

In working to the north an underground water course was struck and work was begun in a S. E. direction in which

position they are now driving, the deposit having been proved in that direction. To show the greater regularity and persistence of this bed the fact may be mentioned that in searching for the gypsum no particular attention is paid to knolls or rises of ground as at other localities, but the attack of the deposit goes steadily on without reference to surface inequalities, the gypsum being found regularly in depressions as well as on knolls, although not so thick. The amount quarried this year by the company as stated by the secretary of the company would be 10,000 or 12,000 tons. Their product has fallen off considerably in late years, due to causes which I will try to explain later on. The selling price of the plaster F. O. B. is $2.50 per ton ground. The company ship either in bulk or in bags and either in the lump or ground, the latter of course costing more. It is said that the company ships most of this plaster to other sections of the state and also to adjoining states. The plaster is all of one grade and is called Cayuga Land Plaster. A fair day's work for the mill is 50 tons, but this can be increased considerably if necessary. Mr C. T. Backus of Union Springs is the president of the company. Mr Amos Clark of Union Springs is the treasurer.

The operation of the mill is as follows: The gypsum is first put through a Blake crusher, crushing to egg size and smaller. Thence it goes to the "cracker" which is of the coffee mill type of grinder. It is then elevated by conveyors of the link belt type to a hopper; from this the material goes to the burr stones, which crush it to a powder which is grayish white in color. This powder is then conveyed to a large store room and when this room is full a conveyor transports the material to another large store room. From the store room the plaster is loaded on small cars, weighed and run into railroad cars for shipment. At present the material is all used for fertilizer. Mr Backus states that he intends to experiment on calcining his gypsum in the near future. The regular force of employees is 18 or

20, their pay being $1.50 per working day. The plaster is easily handled, breaking up with hammer and sledges along planes of cleavage into masses resembling paving blocks. A few small faults are observable in the workings and slips are frequent. The general color of the quarried gypsum or "rock" is gray, with plates of selenite coating the blocks and more or less intermingled with the impure mineral. Large crystals are occasionally found. The weather has a disintegrating effect on the gypsum tending to break it up into dirt and small pieces which are thrown away as only the blocks are carted away for grinding. The burr stones for fine grinding are in five sets, three sets being $3\frac{1}{2}$ ft. in diameter and the remaining two sets $4\frac{1}{2}$ ft. in diameter and all about 10″ thick. The $3\frac{1}{2}'$ set have the understone running, while in the $4\frac{1}{2}'$ set the upper stone runs. The latter is a new arrangement and is claimed by some to give better results than the under run. It may be stated that the store houses before mentioned serve also as drying houses, the considerable amount of moisture present in the stone when taken out preventing the best results in grinding. The burr stones are notched or ground to allow disposal of the crushed stone. 40 ft. of thickness is the maximum reached in this quarry and that is in an old working. 8 ft. of top rock and 8 ft. of bottom rock with about 3 ft. of shale is being worked at present. This varies however with the rise and fall of the surface. Several old quarries are found in the vicinity that are known as the Fitch and Patterson quarries, neither are working, however, although at the Fitch quarry a little gypsum was ground last winter.

The next point west where quarrying is done is in the town of Phelps, by A. D. Miller. He has a mill which runs with water. His price is $2.75 per ton. The quarry is on Canandaigua outlet and is well exposed, making the attack very easy.

The next point west is Victor where Theodore Conover has a quarry some distance from the village. He has a mill

worked by steam. His gypsum sells for $3 per ton to phosphate companies and $4 per ton to the retail trade.

At Port Gibson, which is about 4 miles from Mr Miller's quarry and mill at Phelps, and to the north on the border between Ontario and Wayne Cos., Mr Ezra Grinnell has a quarry of plaster and a mill worked by water. Mr Grinnell has not worked any this year. The characteristic of this rock is that it is disseminated with crystals of gypsum or "isinglass" as it is locally called. The plaster is found in the bed of a stream near Mr Grinnell's residence. The greatest thickness he has worked is 18 ft. The stream is diverted for the use of a mill leaving the bed in condition, to work with some pumping. Large blasts are put in and a large amount of rock is loosened at a blast.

The next locality west where plaster is quarried is in Garbuttsville in Monroe Co. where Mr Samuel W. Weeks and Mr J. W. Garbutt are operating. The quarries here are all underground, and the product is known commercially as Caledonia White Land Plaster. Mr Weeks is at present operating only one pit but two have been worked this year. The pit now working was dug last spring and the shaft is 53 ft. deep. The thickness of the plaster rock varies between 4 and 8 ft. averaging perhaps 6 or 7 ft. The material is a gray plaster. Mr Weeks does a business of about 2000 tons per year. FF black powder is used for blasting and wheelbarrows are used for handling the product underground. The rock above the plaster is a kind of water lime and the rock under is a lime stone. A few feet below a second plaster bed is known to exist. These beds are known in places but they are run out in places to two, one or none. Short drills are used. The product is drawn to the mill in wagons. The gypsum is harder towards the bottom layer and is sometimes difficult to loosen from the associated rock. The bottom layer of gypsum or "hard plaster" will average from 18 ft. to 20 ft., then comes a bed from 14 ft. to 18 ft. thick, both of these are more or less whitish in appearance.

The rest is gray plaster to the roof, sometimes solid and sometimes interrupted by much loose dirt and by hollows. The mill is run by steam power.

Mr John W. Garbutt operates 3 pits and works 20 men in the season. His capacity is about 4000 tons per year his pits being operated similar to Mr Weeks'. His shafts however are only from 25 to 30 ft. deep and he operates the second bed only, his bed running about 6 ft. thick. According to Mr Garbutt gypsum has been worked in this locality for 80 years. He states that the presence of three plaster beds here is well known their respective thicknesses being about 6 ft.

Mumford, the next gypsum locality to the west, is only a few miles from Garbuttsville. The rock quarried is whiter than at Garbuttsville. The Wheatland Land Plaster Co. owns three pits here, of which two are now working. The officers of the company are Sylvester Brownell, President; W. D. Strobell, Treasurer; Warren H. Pease, Secretary. The other members of the company are D. P. Campbell and George C. Haaly, all residents of Mumford. The product for October and November, 1892, each, was 380 tons. Four men are employed at each pit and 3 men in the mill. This company has just begun to operate this year, although these quarries have been worked before some years. It expects to do a business of some 10,000 tons per year when well started, the present capacity being about 5,000 tons per year. The plaster rock will average 6 ft. in thickness, the roof being of water lime which is solid. The existence of three plaster beds here is confidently believed. The plaster is very flat here; wheelbarrows are used to handle the material. Four men are the regular force in each pit. In a new pit dug recently, considerable difficulty was met with in the quantity of water, so it was closed up until dry weather, when it is proposed to operate it. The beds run as follows: 18 ft. of hard bottom, 18 ft. of white gypsum, and the rest up to about 6 or 7 ft. is mostly gray. Sometimes the stone

is solid with the roof; sometimes "ashes" or earthy gypsum are found up to perhaps 2 ft. in thickness. The mill which the company have put up is a new one this year. The material is broken into suitable pieces with sledges, is then put through a crusher, from which it is elevated to a set of burr stones. From these it is carried by an elevator to hoppers where it is weighed automatically and is dropped through a chute into cars. The material is largely shipped to Buffalo the local trade being small. The amount paid to miners is 60 cents per ton on the bank, the powder being provided by the company. Some dynamite of a low grade is also used. A twist drill was noticed in one of the pits and the quarrymen rather like its operation and ease of working. No. 1 shaft has been worked for several years. No. 2 was opened this year and No. 3 is not yet completed.

No. 1 pit is about 200 ft. from the No. 2, and No. 2 about 100 ft. from No. 3. The ground plaster of this company is of excellent quality and color and the deposit will probably be operated in future on a larger scale.

The next point west is Oakfield in Genesee Co. There are three plaster quarries here owned or leased by Mr Olmsted of Oakfield. Only two are working, both underground. They are almost 1½ miles north of the village. The most easterly pit is worked by four men. The shaft is 8 x 12 and 31 ft. deep. A former owner ran a tunnel to the north which is now closed up. There are two tunnels at present, one 75 ft. long, the other 55 or 60 ft. long. These are separated 80 or 85 ft. at the ends. The 55 ft. tunnel is at present being worked. The deposit is only about 4 ft. thick, not so much as this in many places. The only timbering is a few short stalls. The rock is very much the whitest plaster rock seen in New York, and when ground is like flour. The material is loaded in flat cars running on a track made by laying stringers and nailing cross pieces, and covering with hoop iron. This lessens the labor of handling and increases the output. At the bottom of the pit the material is loaded into an iron

bucket fastened to an iron chain which is operated by a horse whim and derrick at the surface. Mr Olmsted states that the second plaster bed is about 15 ft. thick and lies over 100 ft. below the surface. He expects to drill for the second plaster bed and may work it. He is at present experimenting in calcining his gypsum for stucco, the material calcined and mixed with water setting in 10 minutes to a very hard, compact mass. A favorite place for prospecting for gypsum is on the knolls or rises in ground; in fact this custom is very generally adopted throughout the state in working gypsum deposits. The capacity of Mr Olmsted's pits is about 15 tons per day. Mr Olmsted claims 90% of pure gypsum in his rock.

Two miles and a half south of Alabama Station, W. S. R. R. in Genesee Co. Mr Gilmore quarries some gypsum in the Tonawanda Indian reservation. Last year he quarried about 200 tons. This is the most westerly locality where gypsum is worked.

At Halfway, town of Elbridge, Onondaga Co. Mr Kennah owns a quarry of plaster but has not worked it for two years.

At Marcellus Falls in Marcellus township, Onondaga Co. about 2 miles from the station, Mr L. D. Sherman produces 200 to 300 tons of plaster per year. His quarry is along the railroad not far from the station.

Two miles and a half south of Syracuse is a plaster quarry owned by A. E. Alvord of Syracuse. The quarry is worked open and the caps are exposed by stripping some 8 or 10 ft. of drift. The gypsum is about 30 or 35 ft. thick.

It may be stated that about all the rest of the good plaster in Onondaga Co. outside of the Syracuse bed just mentioned lies in the town of De Witt. The material is known as Onondaga Land Plaster. All combined the product obtained from the vicinity of Fayetteville will make the second largest producer of plaster in New York state.

Mr H. H. Lansing has 24 acres of plaster now working and 50 acres not yet worked. He produces about 2,000 tons per year.

Mr Clark Snook owns a quarry near Mr Lansing's but this is not in operation.

Bangs & Gaynor own a quarry adjoining Snook's but have not done any quarrying for some time. At present they are only buyers and millers, buying largely of local producers and shipping to points at a distance.

F. M. Severance is working a quarry on the Wm. Heard estate. This has the greatest consecutive thickness of gypsum rock in the state, the adjoining quarry of Mr Lansing's perhaps equaling it in places. A detailed report of this property will be found later as it is extensive and valuable property.

The Adamant Plaster Co. of Syracuse has a quarry adjoining Severance's but as yet has done no work in it. These quarries contain the best material of this section, the other quarries in the vicinity yielding a more earthy, darker and poorer variety.

Simon Reals states that he quarried 600 tons last summer He does not grind, but sells to Weston & Alvord in Kamesville for grinding. Mr Reals works a 9′ bed on top and a 3′ and a 6′ on bottom with shale between each bed.

Mr Robert Dunlop of Jamesville does a business of perhaps 2,000 tons yearly.

W. W. Candee owns a quarry on Dutch Hill road about ½ mile west of Lansing's quarry. He works 9 ft., 5 ft. and 3 ft. This plaster is quite dark in color. James Rehan of Manlius and T. W. Sheedy of Fayetteville own quarries adjoining each other not worked at present and probably will not be unless trade revives and prices hold better. Their rock is not well thought of locally.

Mr George Taylor owns a small quarry of dark plaster from which he occasionally produces a few tons.

The same may be said of the quarries owned by Richard Tod and A. W. Edwards. Horace Wheeler and Amos Clark each own quarries of same kind as above. All of the last five mentioned are on the other side of the railroad

from the plaster and all lie in the town of Manlius. I believe Mr Edwards said he quarried 300 tons this year from 9 ft. and 5 ft. beds.

Mr Severance states that he believes the plaster business of the section will improve because he believes the wall plaster people will eventually use the material near at hand and thus save heavy expense although the material may be less pure and darker colored than the material now used. As to the cost of obtaining the rock he stated he could quarry for 15 cents per ton when the stripping was off. From that figure the cost might vary to 25 cents per ton and occasionally as high as 50 or 60 cents per ton. The cost of carting to the canal is given as 20 cents per ton.

At Hobokenville 2 miles south of Wampsville on the N. Y. C. Mr Irving Tuttle does a small business in land plaster. He has a quarry on his own farm which however he does not work. His gypsum is obtained from the quarry of John Stisser and is dug by Mr Tuttle. B. F. Winchell also has a quarry from which he digs stone himself and sells to Tuttle. The total product which Tuttle grinds is about 200 tons per year. The plaster is of fair quality and is sold for local use.

Mr Cyrus Werlock of Perryville owns a quarry about 1 mile from Cottons on the E., C. & N. R. R. His quarry is quite large and the gypsum of fair quality.

R. D. Buttons near Cottons has a quarry of plaster from which he gets perhaps 800 tons yearly.

The following brief synopsis of the qualities, etc. of the rock operated by F. M. Severance is submitted. This quarry as stated is on one of the largest, certainly the thickest, and one of the most persistent of the plaster beds in New York state.

The gypsum is in some places 60 ft. thick and is divided into eight well marked layers varying in thickness from eighteen inches to thirty feet. The deposit is covered with some 30 or 40 ft. of shaly rock and limestone. The amount of gypsum ($CaSo_4$) is greatest in the crystalline layers and

least in the brown layers. The rock varies in color from light drab in the cap to a dark brown and all layers appear to become lighter from weathering. The so called slate consists of fibrous, scaly and other forms of crystalline gypsum and is essentially the purest gypsum of the series. The composition is stated to be by analysis:

| | | |
|---|---|---|
| 1 | Calcium sulphate | 80–90% |
| 2 | Calcium carbonate | trace |
| 3 | Magnesium carbonate | 5% or less |
| 4 | Clay | 10% or less |

The amount of carbonates appears to be the greatest in the brown layer showing effervescence in the mass and considerable also in the cap. It is least in the crystalline mass or slate beds. The rock appears to be suitable for plaster of Paris or stucco for walls as samples shown were hard and not brittle. Where whiteness is essential the material cannot be used as the material has a gray color.

As to the actual tonnage of gypsum per year the following is an approximate list:

| | |
|---|---|
| Cayuga Plaster Co | 10 to 12,000 tons |
| Wheatland Land Plaster Co | 5,000 " |
| J. W. Garbutt | 4,000 " |
| Samuel Weeks | 2,000 " |
| Olmsted | 2,000 " |
| F. M. Severance | 4,000 " |
| Lansing & Son | 2,000 " |
| Robert Dunlop | 2,000 " |
| All others not exceeding | 4,000 " |
| Approximate tonnage max | 37,000 " |

Value of product ranges between $2.50 and $4.00 per ton. Taking $2.75 as a fair average the value of the product or the selling price is about $100,000. The gypsum business is not as a general thing conducted on an all the year round basis. The quarrying is to a large extent done by farmers who work their farms in the season and employ their hands in the quarries when there is little farm work to do. This may account to some extent for a variation in the ton-

nage each year. No trouble with water is experienced. The employment of skilled miners with modern and improved implements would effect great economy in the cost of producing the gypsum. Even the use of a light track of hoop iron and small cars would be of advantage in transportation. The introduction of steam drills, the drilling of larger holes, and the use of larger blasts would increase the output greatly with the same force of men. It is well known that a considerable amount of the plaster goes into the composition of the high grade fertilizers. With the increase of the adamant wall plaster business there will probably be an increase over present production of the gypsum business of New York state but as this business is hardly well started yet the effect may not be noted for some time.

## THE USES OF GYPSUM

(1) On land.

The advantage claimed is the increase it gives to many crops to which it is applied, the ease with which it is applied and the small amount which is required, also the cheapness of the article. The manner of action is said to be as follows; the plaster acting as an indirect fertilizer: Ammonia is an alkali capable of decomposing plaster and forming with the acid the sulphate of ammonia. Ammonia is an important element of plant food, is produced in the decomposition of organic bodies, and being a gas lighter than air it is difficult to hold. The sulphate of ammonia is not volatile and is kept in the soil ready for use. The lime is supposed to combine with the carbonic acid which is in the air and is also formed by decomposition, forming carbonate of lime. The ammonia is supposed to be washed out of the air by rain and to come into contact with the plaster. The potash of the surface soils largely formed in dry seasons is also supposed to combine with the sulphuric acid in the gypsum and form sulphate of potash. Plaster may be used on land for crops of wheat, oats, rye, buckwheat, corn, potatoes

and other root crops. It is said to be particularly valuable as a top dressing for clover and timothy.

(2) As a deodorizer, and on compost heaps as an absorbent of the ammonia and in cities and towns to allay the pungent odors of stables, privies and drains.

(3) As the basis or foundation of the adamant or hard plaster for walls, stucco, reliefs etc. (for method of calcining and boiling see article in Grand Rapids *Democrat*, Mich., Nov. 6, 1892). Three companies, the Eureka, the Paragon and the Adamant companies of Syracuse are at present engaged in the manufacture of this hard wall plaster.

As is well known, $CaSo4+2H_2O$ when subjected to heat or "boiling" in kettles will lose its water of crystalization if heated to a certain point. The product when ground and mixed with water sets to a hard, firm mass. Various ingredients are used according to the patent, the processes being recent ones, but it is known that among the hardeners of gypsum are lime-water, gum-arabic, alum, borax and cream of tartar. Whether any of these are used could not be ascertained. The advantages claimed for this wall plaster is that it is hard, durable, fire proof, sets quickly and does not need covering with wall paper. A disagreeable feature is that it is a good conductor of sound, and makes slight noises audible, arising probably from the solid and homogeneous nature of the wall.

The Adamant Manufacturing Co. is the largest of the three concerns and has a capital stock of $150,000. The patent and invention were the work of Prof. Carl Straub of Syracuse. The advantages claimed for this stone by the company are: that it is "cleanly and easy to work, takes a beautiful polish, can be applied winter as well as summer, frost not affecting it. It prevents swelling or cracking and never falls off; it adheres equally well to lath, brick, stone, or iron, and will not cleave off even in case of breakage of water pipes or heavy leakage; its resonant properties render it desirable for churches, halls, opera houses, etc.; it is im-

pervious to rats, does not harbor vermin or the germs of disease, as it is not porous; it can be frescoed, papered, painted, etc. and costs but little more than ordinary hair and mortar plaster." If half of these qualities are real it would seem the company have a good article for sale.

The use of gypsum as the basis of wall plaster is noted not because the gypsum of New York is used in the process (it is not so far as known) but because of a well founded belief among quarrymen that the manufacturers will be compelled to get their raw material near at hand in the future. Also because Mr Olmsted of Oakfield has a stucco works in the experimental stage.

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# TABLE OF SALT WELL AND SHAFT SECTIONS IN NEW YORK.

N. B. The sections at the Greigsville shaft and the Ludlowville and Dundee wells are omitted for want of accurate information.

### Gowanda, Cattaraugus County — (Bishop).

| | Feet. |
|---|---|
| Soil | 6 |
| Shale | 450 |
| Sand, with oil and gas | 4 |
| Shade to "second sand," when more oil and gas were found | 450 |
| Shale | 390 |
| Hard rock (corniferous and Helderberg) | 400 |
| | 1,700 |

### Eden Valley, Erie County — (Bishop).

| | Feet. |
|---|---|
| Shale | 125 |
| Blue hard rock | 200 |
| Black slate | 300 |
| Flint, lime and sand | 400 |
| Brine in soft rock at 1,075 | 50 |
| Total depth | 1,750 |

### East Aurora, Erie County (Bishop).

| | Feet. |
|---|---|
| Shales, black and light colored | 695 |
| Corniferous limestone | 165 |
| From corniferous to salt | 605 |
| | 1,465 |

### Gardenville, Erie County — (Bishop).

| | Feet. |
|---|---|
| Marcellus shales | 60 |
| Limestones (upper and lower Helderberg) | 205 |
| Shale to Niagara limestone | 535 |
| | 800 |

### Leroy, Genesee County — (Bishop).

(*Surface height, 875 feet.*)*

| | First well, ft. | Second well, ft. |
|---|---|---|
| Soil, etc | 23 | 22 |
| Marcellus shale | 10 | 11 |
| Corniferous limestone | 150 | 137 |
| Water-lime (hydraulic limestone) | 40 | 440 |
| Soft rock, saline shales | 427 | |
| | 650 | 610 |

### Batavia, Genesee County — (Prosser).

(*Surface height, 895 feet.*)*

| | Feet. |
|---|---|
| Drift | 40 |
| Marcellus shale | 60 |
| Helderberg, Limestones | 150 |
| Salina group | 500 |
| 15 inches salt 600 feet below surface. | |
| Niagara | 250 |
| Medina | 1,000 |

### Attica, Wyoming County — (Bishop).

(*Surface height, 983 feet.*)*

| | Feet. |
|---|---|
| Soil | 200 |
| Slate, Hamilton | 375 |
| Corniferous limestone | 156 |
| Limestone (lower Helderberg) about | 300 |
| Slate | 104 |
| | 1,135 |

At 1,490 feet some salt in rock till 1,500 feet. Total depth, 1,900 feet. For more details see Bishop's Salt Fields of Western New York.

### Lehigh Salt Mining Co., Lehigh, Genesee County.

(*Surface height, 918 feet.*)*

| | Feet. |
|---|---|
| Soil | 50 |
| Shale | 100 |
| Corniferous limestone, with flint | 150 |
| Hydraulic limestone | 30 |
| Cement stone | 20 |
| Gypsum | 100 |
| Gypsum, shale and limestone in layers four inches to six inches thick | 250 |
| Salt and shale | 75 |
| Rock salt | 30 |
| | 805 |

### Junction of the B. & P. with D., L. & W. R. R., Genesee County — (Bishop).

(*Surface height, 953 feet.*)*

| | Feet. |
|---|---|
| Gravel | 46 |
| Shale | 192 |
| Corniferous limestone | 146 |
| Lower Helderberg limestone | 454 |
| Pure salt (41) | 40 |
| | 878 |

### Pavilion Salt Co., Pavilion, Genesee County — Well No. 2 — (R. D. White).

(*Surface height, 935 feet.*)*

| | Feet. |
|---|---|
| Soil | 50 |
| Soft limestone | 375 |
| Corniferous limestone | 150 |
| Soft limestone | 375 |
| Shale | 50 |
| Salt and shale, mixed | 19 |
| Salt mixed with some shale | 100 |
| | 1,119 |

Bottom in shale rock.

### Moulton Well, Wyoming County — (Th. Avery).

(*Surface height, 946 feet.*)*

| | Feet. |
|---|---|
| Soil | 3 |
| Sand, etc | 50 |
| Slate and soft rock | 50 |
| Shale | 452 |
| Corniferous limestone | 152 |
| Slate, indications of salt brine | 60 |
| Limestone, salt brine | 323 |
| Slate | 34 |
| Shale and rock salt | 27 |
| Rock salt | 85 |
| Slate | 5 |
| | 1,241 |

### Pioneer Well, Wyoming County—(C. B. Matthews).

(*Surface height, 992 feet.*)*

| | Feet. |
|---|---|
| Soil and clay | 40 |
| Bluish shales | 40 |
| Black shales | 220 |
| Limestone | 10 |
| Slates of variable color | 363 |
| Limestone | 100 |
| Corniferous limestone, bitter water below | 92 |
| Gypseous shales | 405 |
| Rock salt at 1,270 feet | 70 |
| Red shale | 190 |
| | 1,530 |

### Salt Vale No. 1, Crystal Salt Company, Wyoming County — (Bishop).

(*Surface height, 983 feet.*)*

| | Feet. |
|---|---|
| Sand, gravel and quicksand | 136 |
| Shale | 634 |
| Corniferous limestone | 146 |
| Shale | 15 |
| Upper and lower limestone | 394 |
| Shale and salt | 50 |
| Solid salt | 61 |
| | 1,436 |

### Miller Well, Warsaw, Wyoming County — (Bishop).

(*Surface height, 1,099 feet.*)*

| | Feet. |
|---|---|
| Shale, Lower Portage and Hamilton | 935 |
| Corniferous limestone | 147 |
| Shale | 12 |
| Lower Helderberg limestone | 400 |
| Shale and salt | 30 |
| Solid salt | 85 |
| | 1,609 |

### Atlantic Salt Company, Warsaw, Wyoming County — (Th. Avery).

(*Surface height, 1,064 feet.*)*

| | Feet. |
|---|---|
| Surface soil, clay, etc | 26 |
| Shale | 874 |
| Corniferous limestone | 148 |
| Limestone, shale and salt | 440 |
| Rock salt | 57 |
| Red shale (or sandstone) | 104 |
| | 1,649 |

### Warsaw Salt Company, Warsaw, Wyoming County — (Englehardt).

(*Surface height, 1,098 feet.*)*

| | Feet. |
|---|---|
| Surface soil, clay | 16 |
| Shale | 940 |
| Corniferous limestone | 156 |
| Lower Helderberg and shale | 430 |
| Shale and salt, mixed | 30 |
| Salt | 6 |
| Shale | 10 |
| Salt | 70 |
| | 1,658 |

### Dr. W. C. Gouinlock, Warsaw, Wyoming County — (Th. Percy).

(*Surface height, 1,122 feet.*)*

| | Feet. |
|---|---|
| Clay | 17 |
| Shales | 1,011 |
| Corniferous limestone | 148 |
| Shales | 75 |
| Lower Helderberg limestones | 300 |
| Shales | 45 |
| Salt and shale, mixed | 37 |
| Main salt bed | 68 |
| | 1,701 |

### Gouinlock and Humphrey, Warsaw, West Side of the Valley — (Bishop).

(*Surface height, 1,322 feet.*)*

| | Feet. |
|---|---|
| Shales | 1,330 |
| Corniferous limestone | 150 |
| Struck salt at | 1,803 |
| Salt and shale | 19 |
| Shale | 3 |
| Salt and shale | 12 |
| Salt | 24 |
| Shale with a little salt | 2 |
| Salt | 16 |
| | 1,879 |

### Bradley, Warsaw, Wyoming County — (Th. Percy).

(*Surface height, 1,329 feet.*)*

| | Feet. |
|---|---|
| Soil | 9 |
| Shale (sandstone) | 450 |
| Slate | 856 |
| Corniferous limestone | 235 |
| Flint rock | 70 |
| Lower Helderberg | 365 |
| Salt | 54 |
| "Pocket" | 10 |
| | 2,039 |

### Rock Glen (Alex. Kerr, Bro. & Co.), Wyoming County — (Bishop.)

(*Surface height, 1,312 feet.*)*

| | Feet. |
|---|---|
| Soil, etc | 128½ |
| Sandstone and shale | 1,361½ |
| Corniferous limestone | 140 |
| Lower Helderberg | 385 |
| Salt | 25 |
| Shale | 31 |
| Salt | 40 |
| | 2,111 |

### Perry, Wyoming County — (Bishop).

(*Surface height, 1,335 feet.*)*

| | Feet. |
|---|---|
| Slate | 1,462½ |
| Limestones | 580 |
| Salt and shale | 10 |
| Solid salt | 15 |
| Slate with little salt | 40 |
| Salt and shale in about equal parts | 30 |
| Solid salt | 25 |
| Slate | 18 |
| | 2,180½ |

### Duncan Salt Co., Silver Springs, Wyoming County — (Bishop).

(*Surface height, 1,354 feet.*)*

| | Feet. |
|---|---|
| Gravel and quicksand | 222 |
| Slate and sandstones | 1,299 |
| Corniferous limestone | 140 |
| Limestone (Helderberg) | 330 |
| Slate | 128 |
| Salt and shale, mixed | 15 |
| Pure salt | 10 |
| Slate | 45 |
| Salt, pure | 75 |
| | 2,254 |

### Castile, Wyoming County — (Bishop).

(*Surface height, 1,367 feet.*)*

| | Feet. |
|---|---|
| Soil | 49 |
| Argillaceous sandstone | 175 or 180 |
| Blue shale, nearly uniform in color and hardness | 786 |
| Flint shell | 10 |
| Building-stone, nearly like the first | 650 |
| Black shale, nearly like coal, lower part much darker than upper (Marcellus shale) | 100 |
| Corniferous limestone | 140 |
| Alternate layers of hard and soft rock, two-thirds of which was as hard as flint and the rest shale | 320 |
| Soft slate saturated with brine | 100 |
| Salt and shale mixed, some salt crystals | 35 |
| Clear salt | 45 |
| Slate | 40 |
| Salt and slate, five feet of which was salt | 70 |
| | 2,525 |

### Gainesville Salt Company's Well, Gainesville Creek, Wyoming County — (R. D. White).

(*Surface height, 1,610 feet.*)*

| | Feet. |
|---|---|
| Soil | 358 |
| Soft rock | 460 |
| To corniferous limestone | 1,875 |
| Corniferous limestone | 125 |
| Helderberg rock | 450 |
| Pure salt | 30 |
| Shale | 28 |
| Salt | 6 |
| Shale down to Niagara | |

### Bliss Salt & Oil Company, Bliss, Wyoming County — (R. D. White).

(*Surface height, 1,729 feet.*)*

| | Feet. |
|---|---|
| Soil | 55 |
| To gas sand | 580 |
| First gas sand | 40 |
| Rock | 525 |
| Second gas and oil sand | 100 |
| Shale and black rock | 400 |
| Third gas sand | 14 |
| Black and white shale | 286 |
| Flint | 100 |
| Lime rock and flint (solid) | 800 |
| Salt (very pure) | 56 |
| Lime rock (solid) | |
| | 2,956 |

### Nunda, Livingston County — (Mr. Hambly).

(*Surface height, 850 feet.*)*

| | Feet. |
|---|---|
| Blue shale | 65 |
| Black shale, with some gas | 468 |
| Argillaceous sandstone | 10 |
| Light-colored slate, with a small show of oil | 473 |
| Hard shell-rock | 8 |
| Slate | 544 |
| Iron pyrites | 40 |
| Corniferous limestone | 210 |
| Slate | 182 |
| Sand-rock | 60 |
| Salt and shale, mixed | 10 |
| Pure salt | 35 |
| Salt and shale, mixed | 35 |
| Black shale without salt | 85 |
| | 2,225 |

### Caledonia, Livingston County — (C. L. Goodwin).

(*Surface height, 618 feet.*)*

| | Feet. |
|---|---|
| Surface soil | 6 |
| Marcellus shale | 20 |
| Corniferous limestone | 148 |
| Gypsum and shale | 50 |
| Hydraulic lime and Helderberg | 151 |
| Shales and rock | 225 |
| Saline shale (brine at 600 feet) | 50 |
| Salt | 25 |
| Rock | 73 |
| | 748 |

### York, Livingston County, York Salt Company — (M. B. Gilman).

(*Surface height, 568 feet.*)*

| | Feet. |
|---|---|
| Clay | 52 |
| Hamilton shale | 128 |
| Corniferous limestone | 140 |
| Helderberg limestone | 330 |
| Red shale | 10 |
| Blue and green shales | 34 |
| Salt and shales, mixed | 6 |
| Salt | 10 |
| Shale | 27 |
| Salt | 41 |
| | 828 |

### Piffard, Livingston County, Livingston Salt Company. — (Englehardt).

(*Surface height, 564 feet.*)*

| | Feet. |
|---|---|
| Soil, etc | 188 |
| Shale | 77 |
| Corniferous limestone | 150 |
| Lower Helderberg and shales | 458 |
| Salt | 18 |
| Shale | 6 |
| Salt | 11 |
| Shale | 4 |
| Salt | 9 |
| Shale | 20 |
| Salt | 62 |
| | 961 |

### Piffard, Livingston County, Genesee Salt Company — (Englehardt).

(*Surface height, 568 feet.*)*

| | Feet. |
|---|---|
| Clay and gravel | 64 |
| Limestone and shale | 186 |
| Corniferous limestone | 142 |
| Slate | 3 |
| Gray lime (water-lime) | 313 |
| Slate and shale | 167 |
| Rock salt | 13 |
| Shale | 24 |
| Rock salt | 6 |
| Shale | 7 |
| Rock salt | 58 |
| Shale | 4 |
| | 987 |

Brine of 68° Salometer at 708 feet.

### Piffard, Livingston County, Retsof Mining Co.

*First well sunk on the property where the shaft is now.*

| | Feet. |
|---|---|
| Shale and slate | 28 |
| Shales, Hamilton | 373 |
| Corniferous limestone | 146 |
| Shale (water-lime) | 68 |
| Helderberg, upper and lower | 322 |
| Water-lime | 80 |
| Salt | 4 |
| Shale | 12 |
| Salt | 18 |
| Shale | 32 |
| Salt | 58 |
| | 1,141 |

### Well Short Distance Above Genesee Company's Works — (Englehardt.)

| | Feet. |
|---|---|
| To rock salt | 936 |
| Rock salt | 2 |
| Shale | 4 |
| Rock salt | 12 |
| Shale | 28 |
| Rock salt | 6 |
| Shale | 9 |
| Rock salt | 54 |
| | 1,051 |

### Piffard, Livingston County — Retsof Mining Co. (Ch. Cocher).

(*Surface height, 714 feet.*)*

| | Feet. |
|---|---|
| Encrinal limestone | 8 |
| Hamilton shale (Moscow shale) | 40 |
| Dark shales | 93 |
| Limestone | 8 |
| Ludlow shales (Hamilton shale) | 216 |
| Limestone | 4 |
| Marcellus shale | 39 |
| Corniferous limestone | 2 |
| Shale | 1 |
| Corniferous limestone | 140 |
| Onondaga limestone | 1 |
| Hydraulic limestone (water-lime) | 13 |
| Sandstone | 14 |
| Gypsum | 4 |
| Hydraulic limestone | 25 |
| Gypsum | 47 |
| Magnesian limestone (water-lime) | 63 |
| Hydraulic limestone | 14 |
| Blue shales | 25 |
| Helderberg limestone | 10 |
| Blue shales | 12 |
| Helderberg limestone | 17 |
| Limestone and sandstone | 31 |
| Hydraulic limestone | 10 |
| Limestone and cement | 15 |
| Hydraulic limestone | 6 |
| Blue shale | 10 |
| Red shale | 12 |
| Limestone | 41 |
| Red shale | 5 |
| Blue shale | 12 |
| Limestone | 12 |
| Salt shale | 51 |
| Rock salt | 2 |
| | 1,012 |

### Greigsville, Livingston County — (Ch. Cocher).

| | Feet. |
|---|---|
| Alluvial deposit sand, clay, etc | 60 |
| Rocks belonging to the Hamilton group | 112 |
| Limestone | 10 |
| Marcellus shale, etc | 260 |
| Corniferous limestone | 150 |
| Onondaga limestone | 10 |
| Water-lime | 40 |
| Gypseous shale | 75 |
| Red shale | 12 |
| Limestone | 12 |
| Green and red shales, alternating | 269 |
| Total depth to the salt | 1,010 |
| First salt vein, followed by shale | 2 |
| Second salt vein, with shale below | 4 |
| Third salt vein, with shale below | 19 |
| Fourth salt vein | 58 |
| Shale between salt veins | 45 |
| | 1,138 |

### Another Well, Three-fourths Miles South.

| | Feet. |
|---|---|
| Alluvium | 105 |
| Hamilton shales | 145 |
| Limestone | 12 |
| Marcellus (etc.) shale | 182 |
| Corniferous limestone | 148 |
| Onondaga limestone | 10 |
| Water-lime | 78 |
| Gypseous shale | 90 |
| Green and red shale | 275 |
| First salt bed | 19 |
| Second salt bed | 6 |
| Third salt bed | 6 |
| Fourth salt bed | 6 |
| With shale between veins | 63 |
| | 1,145 |

### Phœnix Salt Company, Cuylerville, Livingston County — (Rev. Ripply).

(*Surface height, 568 feet.*)*

| | Feet |
|---|---|
| Soil, etc | 184 |
| Hamilton shales | 286 |
| Corniferous limestone | 140 |
| Water-lime and shale | 500 |
| Salt | 4 |
| Shale | 3 |
| Salt | 28 |
| | 1,145 |

### Lackawanna Salt Company, Mount Morris, Livingston County — (Bishop).

| | Feet. |
|---|---|
| Hamilton shale | 600 |
| Corniferous limestone | 140 |
| Lower Helderberg limestone and shale | 463 |
| Salt and shale, mixed | 13 |
| Salt, pure | 33 |
| Hard rock | 20 |
| Salt | 75 |
| | 1,350 |

### Mount Morris, Livingston County, Royal Salt Company — (Graham).

| | Feet. |
|---|---|
| Soil | 191 |
| Shale | 479 |
| Corniferous limestone | 150 |
| Water-lime | 50 |
| Lower Helderberg | 250 |
| Salina shales | 170 |
| Salt and shale, mixed | 4 |
| Salt | 20 |
| Slate | 35 |
| Salt (drills stopped in salt) | 73 |
| | 1,422 |

### Lakeville, Livingston County, Conesus Lake Salt and Mining Company — (Bishop).

(*Surface height, 824 feet.*)*

| | Feet. |
|---|---|
| Soil | 54 |
| Shale, lower part bituminous, with gas and some oil | 454 |
| Corniferous limestone | 140 |
| Helderberg limestone | 325 |
| Shale | 5 |
| Salt (very clear) | 25 |
| Soft shale | 30 |
| Salt | 15 or 20 |
| | 1,053 |

### Livonia Well, Bored by Mr. Townsend, one-half Mile North of Livonia.

(*Surface height, 1,008 feet.*)*

| | Feet. |
|---|---|
| Gravel | 90 |
| Sand and clay | 250 |
| Slate rock | 65 |
| | 6 |
| Sandstone | 10 |
| Slate rock | 284 |
| Flint rock | 140 |
| Limestone | 345 |
| Slate and salt | 5 |
| Salt | 32½ |
| | 1,327½ |

### Livonia Shaft — (D. D. Luther).

(*Surface height, 1,082 feet.*)*

| | ft. in. |
|---|---|
| Drift | 64 |
| Hamilton shales and limestones | 748 |
| Marcellus shales and limestones | 54 |
| Corniferous cherty limestone | 135 |
| Water lime | 23 |
| Gypseous shales and limestones | 324 |
| First salt in thin veins | |
| Shales and limestones with salt and gypsum in small proportion | 21 |
| First salt bed 8 in. to 3 ft. thick | |
| Shale | 4 |
| Shale, with salt in seams and veins | 2 |
| Crystalline salt | 2 |
| 6 in. shale | 1 |
| Salt with fragments of shale | 11 |
| Salt | 13 |
| Limestone | 6 |
| Shale | 1 6 |
| Salt with fragments of shale | 15 6 |
| Limestone | 2 |
| Shale with thin layers of salt | 4 |
| Bottom of shaft | 31 6 |
| | 1,431 6 |

### Dansville Oil, Gas and Mining Co., Dansville, Livingston County — (Mr. Burgess).

| | Feet. |
|---|---|
| Soil | 20 |
| Gravel | 10 |
| Hard gritty shale | 70 |
| Gritty slate | 20 |
| Dark sand like Bradford | 15 |
| Slate and shale | 1,565 |
| Hard limestone (dark color) | 80 |
| Hard "granite" (corniferous) | 80 |
| Hard limestone | 40 |
| Limestone (very hard) | 200 |
| Solid salt (dry rock) | 60 |
| Hard limestone | 70 |
| Crooked hole | 10 |
| | 2,240 |

### Bristol, Ontario County, at Muttonville — (Y. W. Smith).

| | Feet. |
|---|---|
| Shale about | 550 |
| Limestone about | 450 |
| Then more than 300 feet of shale and salt, with rock salt at the bottom — (Bishop). | |

### Clifton Springs, Ontario County — (J. S. Hanna).

| | Feet. |
|---|---|
| Corniferous limestone | 70 |
| Limestone | 6 |
| Corniferous limestone | 65 |
| Hard sand-rock | 12 |
| Slates and shales | 497 |
| Salt (reported, but not there) | 20 |
| Shale and slate | 40 |
| | 710 |

### Ithaca, Tompkins County — (Prosser).

| | Feet. | Depth of well, ft. |
|---|---|---|
| Lower Portage shales | 340 | 340 |
| Genesee shale | 100 | 440 |
| Tully limestone | 30 | 470 |
| Hamilton group | 1,142 | 1,612 |
| Marcellus shale | 82 | 1,694 |
| Corniferous limestone | 78 | 1,772 |
| Oriskany sandstone | 13 | 1,785 |
| Lower Helderberg limestone | 115 | 1,900 |
| Shale | 344 | 2,244 |
| First rock salt | 24 | 2,268 |
| Shale | 6 | 2,274 |
| Second rock salt | 54 | 2,328 |
| Shale | 12 | 2,340 |
| Third rock salt | 17 | 2,357 |
| Shale | 31 | 2,388 |
| Fourth rock salt | 21 | 2,409 |
| Shale | 67 | 2,476 |
| Fifth rock salt | 42 | 2,518 |
| Shale | 24 | 2,542 |
| Sixth rock salt | 48 | 2,590 |
| Shale | 82 | 2,672 |
| Seventh rock salt | 42 | 2,714 |
| Green shale | 308 | 3,022 |
| Mottled red and green shale | 6 | 3,028 |
| Green shale | 157 | 3,185 |
| | 3,185 | |

### Aurora, Cayuga County — (W. B. Cogswell).

| | Feet. |
|---|---|
| Soil | 5 |
| Blue clay | 10 |
| Gravel and shale | 95 |
| Slate | 245 |
| Fine black sand | 20 |
| Slate (cased off at 485 feet) | 110 |
| Slate | 15 |
| Corniferous limestone | 175 |
| Slate (strong flow of brine, 500 feet) | 30 |
| Limestone (gives sand) | 25 |
| Slate | 100 |
| Gypsum (strong brine, 840 feet) | 108 |
| Salt rock, later found to be salt shale | 60 |
| Shale | 45 |
| Gypsum | 25 |
| | 1,068 |

### Syracuse, Onondaga County, Deep State Well of 1884 — (Englehardt).

| | Feet. |
|---|---|
| Red shales, followed by sand gravel, etc | 578 |
| Niagara limestone and shales | 72 |
| Limestones and shales | 345 |
| Clinton iron ore | 5 |
| Shales | 5 |
| Shales, magnesian limestone with quartz particles fist noticed | 3 |
| Shales with quartz and sand alternating | 67 |
| Red-brown sandstone alternating with gray, brown, green, etc., with shale | 374 |
| Sandstone of various colors predominating with some shale and slate mixed in layers | 520 |
| | 1,969 |

For fuller particulars in regard to this well and the Gale well, see report for 1884.

### Cardiff, Onondaga County, Solvay Process Company — (Englehardt).

| | Feet. |
|---|---|
| Hamilton shales | 244 |
| Corniferous limestone | 148 |
| Upper and lower Helderberg | 352 |
| Red shales | 100 |
| | 844 |

### Jamesville, Onondaga County — (Englehardt).

| | Feet. |
|---|---|
| Water lime and gypseous shales | 587 |
| Red shales | 453 |
| Stopped in the red shales at | 1,040 |

### Tully, Onondaga County, Solvay Process Company — (Englehardt).

| | Feet. |
|---|---|
| Hamilton shales | 678 |
| Marcellus shales | 40 |
| Corniferous limestone | 150 |
| Water-lime | 50 |
| Helderberg limestone | 294 |
| Rock salt | 47 |
| | 1,259 |

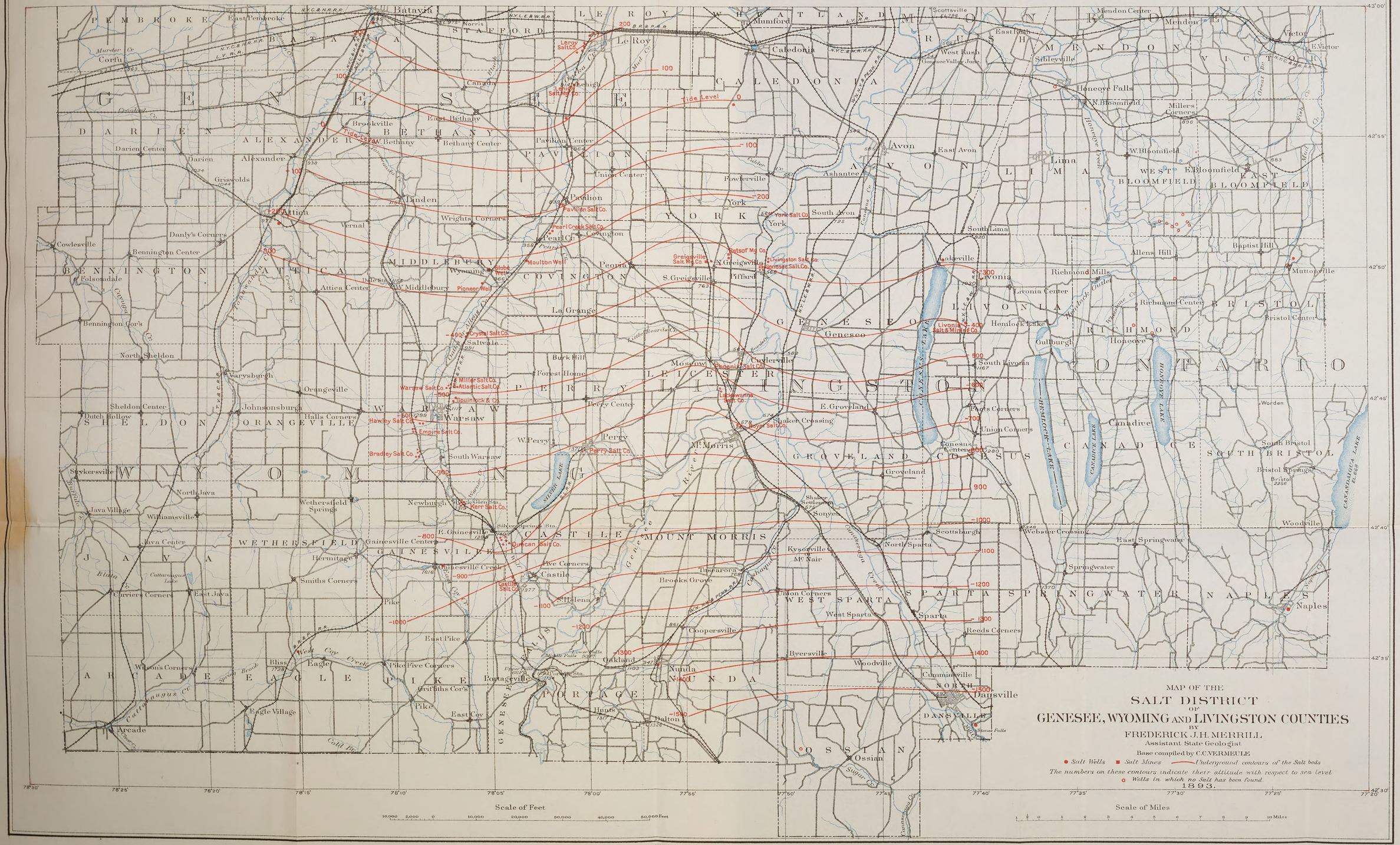
### Green Point, Onondaga County, "Gale" Well. — (Englehardt).

| | Feet. |
|---|---|
| Red shale | 536 |
| Niagara limestone and shales | 69 |
| Limestone and shales | 371 |
| Clinton ore | 10 |
| Shales with some limestone | 10 |
| Dirty brown and gray sand-mixed quartz first noticed | 4 |
| Shales, sandstone and quartz alternating | 55 |
| Sandstones and shales of various colors mixed with quartz, etc., to bottom of well | 545 |
| | 1,600 |

### Morrisville, Madison County — (Prosser).

| | Feet. | Depth. |
|---|---|---|
| Hamilton shales | 340 | 340 |
| Marcellus shales | 31 | 371 |
| Corniferous limestone | 70 | 441 |
| Lower Helderberg limestone | 209 | 650 |
| Hydraulic limestone | 325 | 975 |
| Light gray shale | 43 | 1,018 |
| Dark red shales | 5 | 1,023 |
| Green and blue marls | 87 | 1,110 |
| Green and blue marls with 30 feet of limestone | 149 | 1,259 |
| Rock salt | 10–12 | 1,271 |
| Red and green variegated marls | 129 | 1,400 |
| Red marl | 60 | 1,460 |
| Green and blue marls | 105 | 1,565 |
| Red shale | 225 | 1,790 |
| Blue shale and limestone, Niagara formation | 59 | 1,849 |
| Blue shales | 22 | 1,874 |
| Blue shale and limestone, Clinton | 15 | 1,889 |
| | 1,889 | |

* Altitude measured from railroad track with hand level or aneroid barometer by Wm. C. Clarke, E. M. Railroad levels furnished by the various railroad companies.



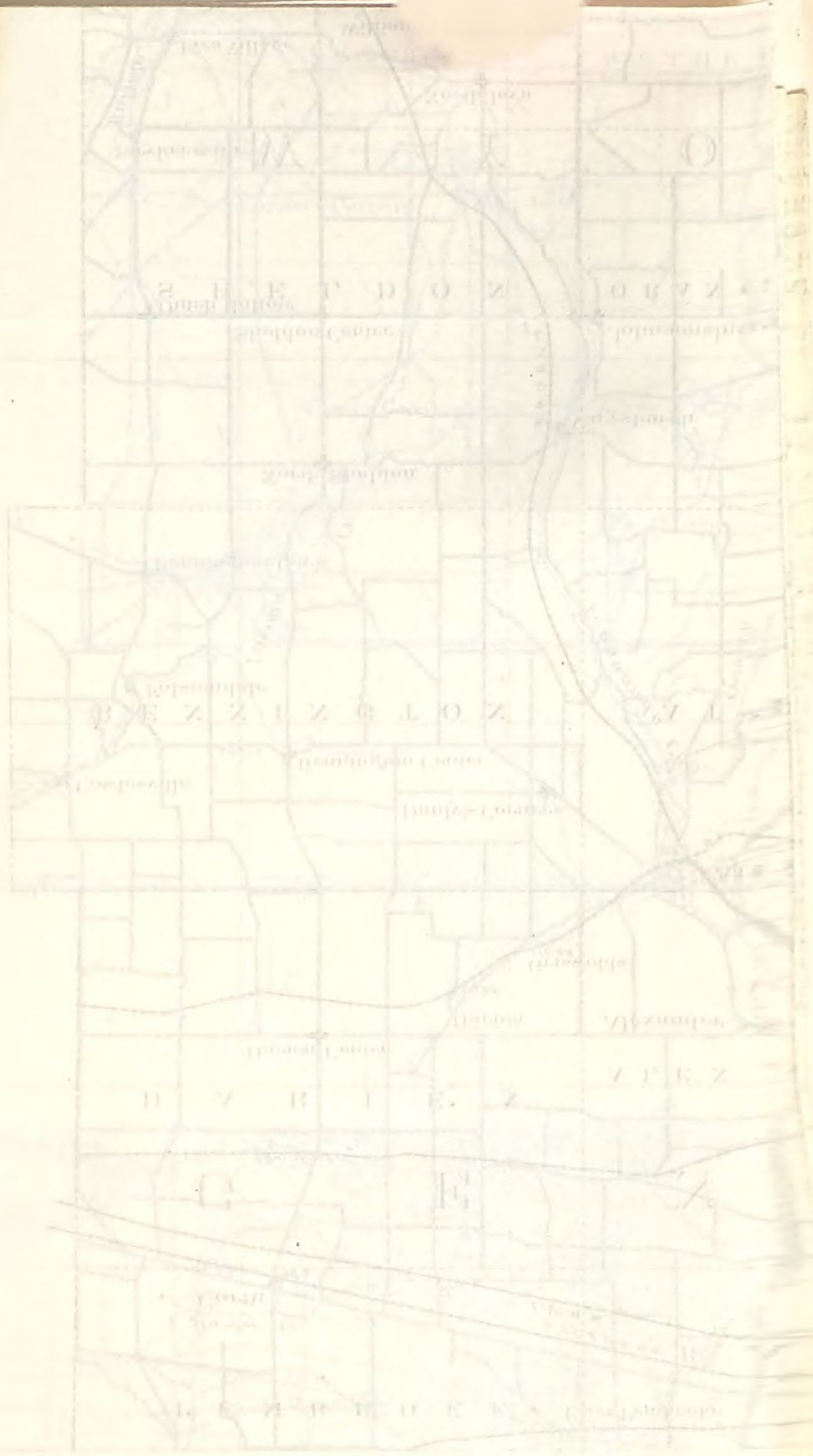

MAP OF THE
# SALT DISTRICT
OF
# GENESEE, WYOMING AND LIVINGSTON COUNTIES

BY
FREDERICK J.H. MERRILL
Assistant State Geologist
Base compiled by C.C.VERMEULE

● *Salt Wells* ■ *Salt Mines* —— *Underground contours of the Salt beds*
*The numbers on these contours indicate their altitude with respect to sea level.*
○ *Wells in which no Salt has been found.*

1893.

JULIUS BIEN & CO. LITH. N.Y.



# MAP OF NEW YORK

SHOWING LOCATION OF SALT WELLS

1893.

BY FREDERICK J. H. MERRILL,
ASSISTANT STATE GEOLOGIST

SCALE IN MILES
10 0 10 20 30

Outcrop of Salina group
Salt shafts
" wells in operation
" " not in operation
Underground contour lines of salt beds
Quarries of Gypsum

Vermeule & Bien
Civil & Mining Engineers.

LONG ISLAND SOUND

JULIUS BIEN & CO. PHOTO LITH.

## University of the State of New York

### NEW YORK STATE MUSEUM

The New York State Museum, organized by act of legislature in 1870 under the title of the "State Museum of Natural History," and placed under the trusteeship of the Regents of the University, is the result of the geological survey of the state commenced in 1836. In that year, pursuant to a resolution passed by the legislature of 1835, Hon. John A. Dix, Secretary of State, formulated a plan for a complete natural history survey of New York. The collections made in the course of this survey form the nucleus of the present State Museum. In 1843 these collections were placed in the old State Hall for safe keeping in charge of a curator. In 1865 the legislature passed resolutions tending toward the expansion of the museum. In 1866 the Cohoes mastodon was discovered and added to the state collection. In 1867 an appropriation was made for the purchase of the Gould collection of shells, and the curator of the state cabinet was directed to make a report upon the building stones of New York. In the preparation of this report specimens were collected which form the nucleus of the present large collection of building-stones. In 1870 the museum was organized by law and an annual appropriation of $10,000 was voted to provide for the salaries of the director and his assistants and for the maintenance of the museum. In addition to this an annual appropriation of $1,500 was made for the salary of a state botanist. In 1881 a state entomologist was appointed who became, in 1883, a member of the museum staff. At this time the annual appropriation was increased to $15,000. In 1889, the State Museum was made an integral part of the University, and the fifth floor of the new capitol was formally assigned for its use. As the new quarters are not yet completed, most of the museum remains on the four floors of Geological Hall in State street, corner of Lodge. Here are the collections in mineralogy, geology, paleontology, zoology and ethnology, and the offices of the assistant director and assistant state geologist, and of the assistant zoologist. The state geologist and paleontologist and the state botanist have their offices in State Hall in Eagle street, and the state entomologist in the north east section of the fourth floor of the capitol. The State Museum in addition to its work of collecting material representative of the natural resources of the state, is also the seat of the geological and natural history survey which has been in progress since 1836 and under the auspices of which numerous reports have been published on geology, paleontology, zoology and botany. The museum is open to the public from 9 a. m. till 5 p. m. daily except Sundays, including vacations, Saturday afternoons and all other holidays.

H. Nat. 95 fb 8°

University of the State of New York

# BULLETIN

OF THE

# New York State Museum

VOL. 3 No. 12

MARCH 1895

# CLAY INDUSTRIES OF NEW YORK

PREPARED UNDER THE DIRECTION OF

FREDERICK J. H. MERRILL, PH. D.

BY

HEINRICH RIES, PH. B.

ALBANY
UNIVERSITY OF THE STATE OF NEW YORK
1895

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|---|---|---|
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University of the State of New York

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1895

## ERRATA

Page 130, line 2, "furstules" should be "frustules."

Page 151, seventh line from bottom, "are refractory" should be "are not refractory."

Page 184, "Jova," not "Jover."

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# Note by the Director.

The study of the Quaternary deposits of the Hudson River valley was undertaken by me several years ago, and a paper on the subject was published in the American Journal of Science.* In continuation of this it seemed important to investigate the economic side of the question and report on the brick industry, which is so highly developed in this region. The confining duties of administrative work in the museum rendered it necessary for me to delegate the work of the economic investigation, and it was placed in the hands of Mr. Heinrich Ries, Ph. B., who, during the summer of 1891, made a careful study of the methods of brick manufacture in the Hudson River valley, and extended the investigation of the Quaternary geology of this region.† During the season of 1892, the necessity for making a representative collection of clays throughout the State of New York, for the World's Columbian Exposition, afforded an opportunity for obtaining information concerning the clay industries of the interior of New York and of Long Island. As the result of his work conducted during these two seasons, Mr Ries has prepared the following report. Nearly every locality of importance in the State has been visited, and as it is the only exhaustive report on the subject which has been prepared in this country, it commends itself to all who seek information concerning the industrial uses of clay in New York

F. J. H. MERRILL,
*Director.*

# PREFACE.

The following report is intended to deal chiefly with the economic aspect of the subject. In the time at my command it has not been possible to visit all the deposits which are being worked, and, therefore, much information has necessarily been gathered by correspondence. The analyses given in the report have all, unless otherwise stated, been made by Dr. H. T. Vulte, of Columbia College, New York city. All the methods described for obtaining the raw material and working it up to a finished product are those employed in the State of New York.

The writer wishes to express his thanks to Dr. F. J. H. Merrill for suggestions offered during the course of the work. Credit for assistance rendered is due to Messrs E. J. Riederer, of New York city, C. L. Sanford of Southold, L. I., E. J. Burke

* Vol. XLI, June, 1891.
†The results of this work were published in the Annual Report of the State Geologist for 1890.

of Rochester. Mr J. J. Clearwater of Highland, N. Y., and Messrs P. H. and J. Conlon of Newark, N. J., have kindly furnished the records of a number of wells bored by them. In the preparation of this report the following books and periodicals have been consulted: The Clay Worker, the Brick-maker, Brick, Tiles and Terra cotta by C. T. Davis, Engineering News, Engineering Record, and the Encyclopedia Britannica.

The increasing value of clay for the manufacture of brick, tile, terra cotta, pottery, etc., and the ever growing demand for these products have given rise to an industry which is rapidly assuming vast proportions, and will in the near future become one of the most extensive and important in the country Scattered over New York are extensive deposits of clay, many of them capable of being used for the manufacture of terra cotta, roofing tile and the coarser grades of pottery. To add to their value the most extensive beds of clay are situated in close proximity to the water ways and railroads which lead to the principal cities of the state. The commoner kinds of clay products, such as building brick, are marketed within the state, but the higher grades, such as terra cotta and roofing tile, have found good markets outside of New York.

The following table gives the receipts derived from the various branches of the clay industry during the year of 1892:

| | |
|---|---|
| Building, front and paving brick | $8,500,000 |
| Terra cotta | 100,000 |
| Sewer pipe | 260,000 |
| Fire brick* | 50,000 |
| Stoneware clay | 10,000 |
| | $8,870,000 |

As will be seen from the above statement bricks are the chief source of income. That the other branches of the clay industry are not further advanced is probably due in a large measure to the fact that the clay deposits of the state have been so little exploited or otherwise examined. Though many of the deposits have been opened up and are still being worked, there are numerous others scattered over the state which are still untouched.

* This does not include those manufactured in the state from clays obtained in other states.

Few of the clays are found to be of sufficiently refractory character to be used for making fire brick, gas retorts, or other products which in use are subjected to a high degree of heat; but for the manufacture of coarse pottery, terra cotta, paving brick, etc., many of the clays are eminently suited.

Within the last four or five years the manufacturers in New York have turned their attention toward the extensive beds of argillaceous shale which the state contains, and which on trial have given very satisfactory results. Several large firms are using them for the manufacture of sewer pipe, terra cotta and roofing tile. The shale formations at present used are the Salina, Hamilton and Chemung. The Hudson River shales are no doubt sufficiently argillaceous over many areas to be used for the manufacture of clay products, and the same may be said of the Niagara shale, which weathers to a red clay. A sample of this latter shale from Niagara Falls was first ground and then molded in a stiff mud machine and found to burn to a white brick, which was unaffected by a temperature of 2,500 degrees.

That the clays and shales of New York are comparatively undeveloped is, no doubt, largely due to the lack of knowledge of their extent and character. There seems, however, to be no reasonable doubt that they will in future become a valuable source of revenue.

HEINRICH RIES.

NEW YORK CITY, April, 1893

# GEOLOGY AND GEOGRAPHY OF THE CLAY DEPOSITS.

Deposits of clay occur in nearly every county of New York. They belong to three geological periods, viz.:

Quaternary, Tertiary and Cretaceous.

The first class is by far the most common. The second class is somewhat indefinite in extent, but a large number of the Long Island deposits probably belong to it.* Of the third class there are undoubted representatives on Long Island and Staten Island, as well as some additional ones on Long Island, which are questionable.

The clays of the mainland are all Quaternary so far as known. The problems of the Quaternary formations in New York are by no means solved, and it is not always possible to decide on the causes leading to the deposition of any particular body of clay by a single visit to the locality.

A great majority of the deposits are local and basin-shaped, lying in the bottoms of valleys which are often broad and fertile. They vary in depth from four to 20 or even 50 feet; as a rule they are underlain by modified drift or by bed rock. The clay is generally of a blue color, the upper few feet being weathered mostly to red. Stratification is rarely present, but streaks of marl are common. In some of the beds small pebbles, usually of limestone, are found, and these have to be separated by special machinery in the process of manufacture. In many instances the clay is covered by a foot or more of peat.

The basin-shaped deposits are no doubt the sites of former ponds or lakes, formed in many instances by the damming up of the valleys, and which have been filled later with the sediment of the streams from the retreating ice sheet. The valleys in which these deposits lie are usually broad and shallow. The broad flat valley in which the Genesee River flows from Mt. Morris to Rochester is a good example. The waters of the river

* F. J. H. Merrill, Geol. of L. I., Ann. N. Y. Acad. Sci., Nov., 1884.

were backed up by the ice for a time, during which the valley was converted into a shallow lake in which a large amount of



Old lake bottom, Spencer, N. Y.

aluminous mud was deposited. This material has been employed for common brick.

An idea of the depth of clay and alluvium in the Genesee valley may be had from the following table:

The figures have been taken from the records of salt wells.

| | | | |
|---|---|---|---|
| York† | York Salt co. | Clay | 52 ft. |
| Piffard† | Genesee Salt co. | Clay and gravel | 64 ft. |
| " † | Livingston Salt co. | "Soil"* | 158 ft. |
| Cuylerville† | ..... | "Soil" | 184 ft. |
| Mt Morris‡ | Royal Salt co. | "Soil" | 191 ft. |

For other localities the following depths are given:

| | | | |
|---|---|---|---|
| Aurora† | ..... | Blue clay | 15 ft. |
| Wyoming† | Pioneer Well | Soil and clay | 40 ft. |
| Warsaw† | Standard Salt co. | Surface, soil and clay | 26 ft. |
| " † | Guinlock and Humphrey | Clay | 17 ft. |

There are a number of these deposits which are of sufficient interest, geologically as well as commercially, to be mentioned in some detail.

---

*The term soil is probably meant to indicate sand and clay.

†I. P. Bishop, 5th Ann. Rep't, N. Y. State Geologist, 1885.

‡Ann. Rep't, Sup't Onondaga Salt Springs for 1888, p. 19.

There is a bed of clay at Dunkirk having a depth of over 20 feet. The upper six feet are yellow and of a sandy nature, while the lower two thirds is blue and of much better quality. It is mentioned by Prof. Hall* in his report, and is an instructive example of the manner in which the clay changes in color, downward as far as the water can percolate and oxydize the iron.

Around Buffalo is an extensive series of flats underlain by a red clay. A thin layer of sand suitable for tempering overlies the clay in spots, and limestone pebbles are scattered through it. Similar deposits occur at several localities to the north of the ridge road and around Niagara Falls, also at Tonawanda and La Salle, to the north of Buffalo, as well as south of it along the shore of Lake Erie. No doubt much of this clay was deposited during the former extension of the Great Lakes.

Prof. Hall mentions deposits of clay at the following localities: at Linden one mile south of Yates Center;† along the shore of Lake Ontario east of Lewiston; on Cashaqua Creek‡ deposits of tenacious clay due to the crumbling of the argillaceous green shales; in Niagara County§ beds of clay are said to occur in every town, but they often contain a considerable amount of lime.

A bed of blue and red clay is being worked at Brighton near Rochester. This deposit lies near the head of Irondequoit bay and was deposited by some stream flowing into it. To the southeast of Rochester is a large esker which extends in a northeast direction to near Brighton. Mr. Upham, who has described this esker, considers that it was formed by a river which flowed between walls of ice and deposited the bed of clay above mentioned.‖

Clays are also found at several points in the valley of the Oswego River from Syracuse to Oswego, an important one being at Three Rivers.

An extensive bed of red and gray clay, 20 acres in extent and horizontally stratified, occurs at Watertown. The deposit is 20 feet thick and rests on Trenton limestone.

---

* Geology of New York, 4th District, 1843, p. 362.
‡ Ibid. p. 227.
† Ibid. p. 437.
§ Ibid, p. 444.
‖ Proc. Amer. Asso. Adv. Sci., vol. XLI.

Another deposit of considerable size is being worked at Ogdensburg. The clay is blue and has a depth of 60 feet.

At Madrid, in St. Lawrence county, is a small deposit, probably the remnant of a formerly extensive one. The section is:

| | |
|---|---|
| Yellow stratified sand | 3 feet |
| Blue clay with shells | 1 " |
| Blue clay | 20 " |
| Total thickness | 24 " |

The shells are probably *Macoma fusca.*

Turning our attention to the southern portion of the state we find clays in abundance, in all the valleys, and lowlands. The extensive marshes near Randolph and Conewango are said to be underlain by clay throughout their entire extent.*

At Levant, four miles east of Jamestown, Chautauqua county, is an interesting bed of blue clay underlying an area of several acres. It is probably of post-glacial age, and the section as determined by an artesian well-boring is :

| | |
|---|---|
| Yellow sand | 4 feet |
| Quicksand | 4 inches |
| Yellow clay. | 5 feet |
| Blue clay | 70 " |
| Hardpan.. | " |
| Total thickness .. | 83 " |

The owner of the clay bed informed me that leaves were often found between the layers of the clay at a depth of 15 or 20 feet.

At Breesport near Elmira is a bank of blue clay rising from the valley to a height of 50 feet. It was evidently formed when the valley was dammed up, and has subsequently been much eroded so that all that now remains is a narrow terrace along the side of the valley. A similar deposit is found at Newfield south of Ithaca. A moraine crosses the valley a mile or two south of it. Deposits of clay suitable for brick and tile occur extensively in the lowlands bordering the Mohawk River from Rome to Schenectady. The beds vary in thickness from six to 15 feet and are mostly of a red, blue, or gray color.

* Geol. New York, 4th district, 1.

Among the most extensive and important clay formations occurring in New York are those of the Hudson valley.* Here are deposits of two types. (1) Estuary deposits of fine stratified sand, yellow and blue clay, and (2) cross bedded delta deposits, the materials of which are much coarser. The estuary deposits indicate a period of depression, and deposition in quiet water. The clay is chiefly blue, but where the overlying sand is wanting or is of slight thickness, it is weathered to yellow, this weathering often extending to a depth of 15 feet below the surface, and to a still greater depth along the line of fissures through which the water can percolate. The depth of oxidation is of course influenced by the nature of the clay; the upper portion weathering easily on account of its more sandy nature and hence looser texture. Horizontal stratification is usually present and the layers of clay are separated by extremely thin laminæ of sand. At some localities the layers of the clay are very thin and alternate with equally thin layers of sandy clay. This condition is found at Haverstraw, Croton, Dutchess Junction, Stony Point, Fishkill, Cornwall, New Windsor, Catskill and Port Ewen. At all of the above-mentioned localities except the last two, the clay is overlain by the delta deposits of rivers tributary to the Hudson, and the alternation of layers may be due to variations in the flow of the rivers emptying at those points, the sandy layers being deposited during period of floods. The delta of Catskill creek has been found at Leeds, some two miles west of the Hudson River.† The delta of Rondout creek which flows into the Hudson at Port Ewen will no doubt be found by following the creek back to the ancient shore line of the Hudson estuary. Isolated ice-scratched bowlders are not uncommonly found in the clay.

There is often a sharp line of division between the yellow weathered portion and the blue or unweathered part of the clay. The line of separation between the clay and overlying sand is also quite distinct in most cases. Of the blue and the yellow clay the former is the more plastic, but both effervesce readily with acid due to the presence of three to six per cent of carbonate of lime, and

*H. Ries, Rep't of N. Y. State Geologist, 1890.
†W. M. Davis, Proc Bos. Soc. Nat. His. Nov. '92.

are therefore, properly speaking, marly clays. The clay is underlain by a bed of gravel, sand, hardpan, bowlder, till or bed rock. From Albany to Catskill the underlying material is a dark gray or black sand with pebbles of shale and quartz. The sand grains are chiefly ground up shale, the rest being siliceous and calcareous with a few grains of feldspar and garnet. This sand can often be used for tempering but at Catskill contains too much lime for this purpose.

I have not observed this underlying sand and gravel to reach a greater height than 90 to 100 feet.

From Catskill northward the clay is in most cases covered by but a foot or two of loam. South of Catskill the character of the overlying material varies. At Catskill a terrace extends back two miles and probably more; it is deeply incised by Catskill and Kaaterskill Creeks and smaller streams; rocky islands project above its surface at various points. Along the West Shore track, about 150 feet south of the station, the side of the cutting consists of thin alternating layers of clay and sand 27 feet thick. Above this in places is nine feet of fine stratified yellowish sand. The clay extends along the track for about one fourth mile until it meets an outcrop of Hudson River sandstone. On the south side of the Catskill Mt. R. R. 100 feet from the bridge is an exposure of sand and gravel, the pebbles being very coarse. It is presumably drift material, but the exposure is an isolated one and does not show its relation to other deposits of the vicinity. At Smith's Dock, on the land of T. Brousseau near the river, the upper portion of the terrace escarpment consists of fine stratified sand, which has been excavated to a depth of 12 feet without finding clay, while farther back from the river the clay extends to within two feet of the terrace level.

The Hudson River shale rises steeply along the water's edge from here down to Malden, and crops out at numerous points in the terrace escarpment. The clay along here is probably not of great depth. Clay is found in the railroad cutting to the north of Malden station, about seven feet above the track level, and clay is exposed in numerous cuttings of the West Shore Railroad, from Malden to Mt. Marion.

From Glasco to Rondout the terrace, which is perhaps one eighth mile broad at Glasco, narrows as it nears Rondout, and

has an average height of 150 feet. The clays, so far as could be ascertained, lie on the upturned edges of the Utica shale.

At the rear of A. S. Staples' yard hardpan underlies the clay. The overlying material at this locality consists of sand and gravel in many instances stratified and sometimes cross-bedded. The sand in some spots is 10 to 15 feet thick and fine enough to be blown by the wind.

At Port Ewen the clay is mostly blue, resting on a mass of hardpan, and in a few places on the glaciated rock surface. According to Mr. Kline, of Port Ewen, the clay around the village is nowhere over 18 feet in actual thickness and is underlaid by hardpan. A point worthy of notice is the difference in level of 50 feet between the terrace at Port Ewen and at Glasco.

It has been suggested by Dr. F. J. H. Merrill that this may be due to the fact that when sediment is deposited in the basin its edge would be higher than the center. The Quaternary formation broadens on toward the west, and Port Ewen would be a point on the basin's edge while Glasco is near the center.

In this connection the following well records are of interest: A boring made on the property of Isaac Tamney, at Eddyville, showed

| | |
|---|---|
| Sandy loam | 10 feet |
| Quicksand | 70 " |
| Blue clay | 10 " |
| Gravel | " |
| | 90 " |

In boring another well at the same locality the following strata were passed through:

| | |
|---|---|
| Yellow clay | 10 feet |
| Blue clay | 137 " |
| Gravel | 5 " |
| | 152 " |

Still another at Rosendale, on the land of R. Lefever:

| | | |
|---|---|---|
| Loam and yellow clay | 20 | feet |
| Sand | 50 | " |
| Blue clay | 30 | " |
| Gravel | ... | " |
| | 100 | " |

At Lefever Falls:

| | | |
|---|---|---|
| Coarse sand | 40 | feet |
| Quicksand | 60 | " |
| Blue clay | 42 | " |
| Rock | ... | " |
| Total thickness | 142 | " |

At Rosendale Plains:

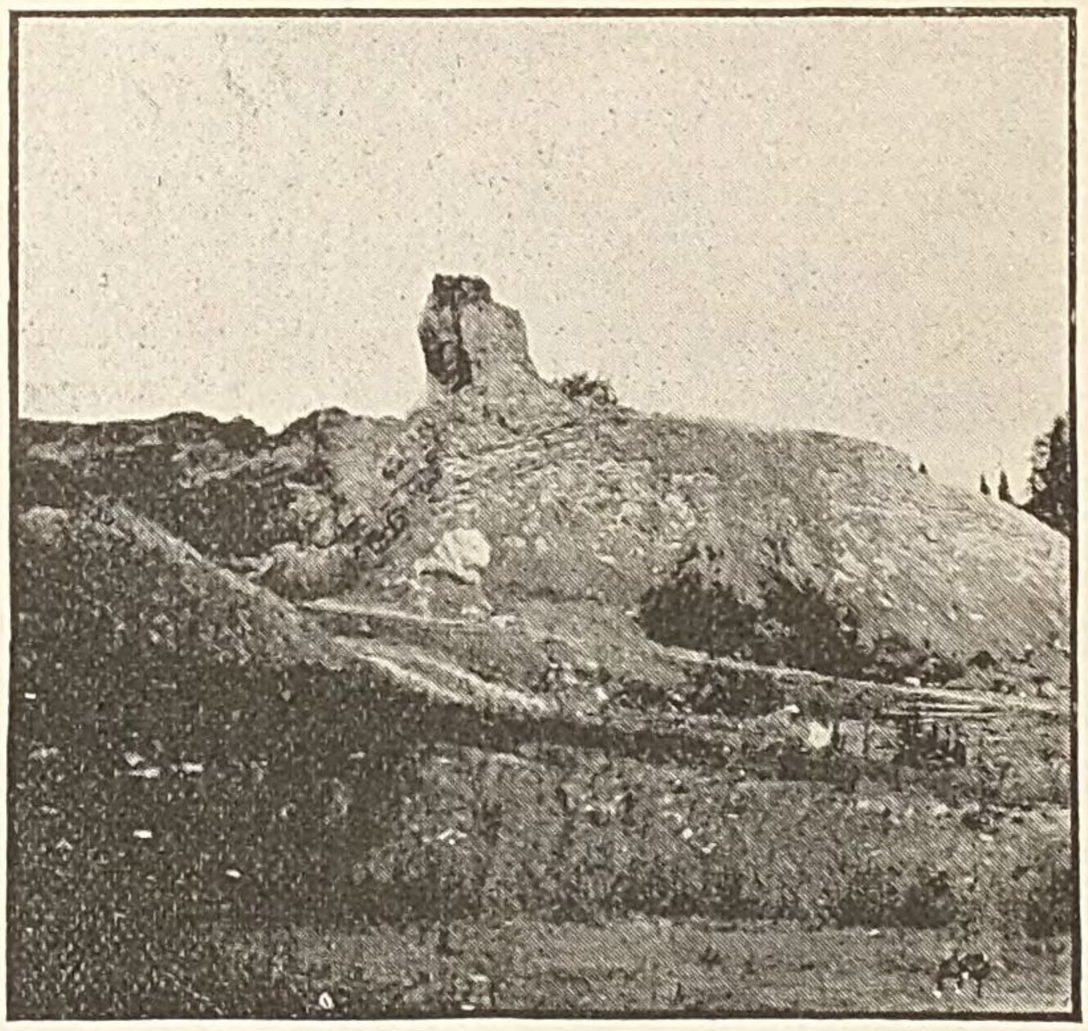
| | | |
|---|---|---|
| Sandy soil | 10 | feet |
| Blue clay | 10 | " |
| Quicksand | 10 | " |
| Blue clay and quicksand alternating | 150 | " |
| Total thickness | 180 | " |

We now come to a narrow portion of the river from Staatsburg to New Hamburg, where the terrace if present is of small extent and presumably underlain by drift material.

Where the river broadens out again at Roseton at the head of Newburg bay, there is a thick bed of clay. It is nearly all blue and underlies the remnant of a terrace 120 feet high, which has escaped entire destruction owing to its position in a reëntrant angle of the upper Cambrian limestone ridge along the river at this point. The overlying stratified sand and gravel is 10 to 15 feet thick. At Jova's upper yard the clay rests on the glaciated limestone, over whose surface are scattered several bowlders of the same rock. The clay at Rose's yard is 180 feet thick, while that at Jova's has a total thickness of 240 feet. A boring of 135 feet made at Rose's yard at river level is of interest in connection with the depth of the preglacial channel of the Hudson.

About 800 feet south of Roseton station the material under the terrace is a yellowish loamy clay, thinly stratified. This may be a portion of the secondary cone of the delta of Wappinger's creek at New Hamburg. North of this a cutting has been made in the terrace escarpment, the section exposed showing alternating layers of yellow and black sand.

From Newburg to New Windsor the clay is overlain by the extensive delta deposits of Quassaic Creek and Moodna River. To



Clay at New Windsor showing glaciated bowlder in it.

the east of Mrs T. Christie's yard the clay, which is mostly blue and thin layered, is overlain by fine gravel and sand obscurely cross stratified in places. Over this is three to four feet sandy soil. The upper layers of the clay are wrinkled in places, probably owing to the oblique downward pressure of the overlying delta deposits. It seems likely that at this spot only a small portion of them remain, much having probably been eroded. At Lang's yard, south of Christie's, there is four to six feet of sand and gravel over the clay, of the same nature as that previously mentioned. Scattered all through the clay are cobbles of limestone. The upper strata are loamy and contorted, while underneath in the yellow clay, which is very tough, the stratification is almost entirely obliterated. At the next bank, also belonging to Lang, there is six feet of overlying sand and gravel. Scattered through the clay are several bowlders of Calciferous sandrock,

sandstone, black crystalline limestone and gneiss. The overlying material is mostly unstratified and many of the pebbles are eight inches in diameter. At the bank of J. T. Moore the clay is very tough, and the stratification is obliterated in spots. Several ice-scratched bowlders of light blue limestone, sandstone and Calciferous sandrock were found in the clay. In Moore & Lahey's bank the clay is tough and compressed, similar to the other yards. It likewise contains scratched bowlders, specially of a light blue crystalline limestone. Over the clay is two to four feet of coarse sand and gravel.

On the west side of the New York, Ontario & Western R. R., where it branches off from the West Shore R. R., a cutting in the hillside shows a cross-bedded, yellowish sand and loamy clay with patches of gravel and cobblestones in it. Following along the track a few hundred feet we come to the clay bank of C. A. and A. P. Hedges. This shows an interesting section of blue clay overlaid by 50 to 60 feet of cross-bedded delta deposits of sand and gravel. The clay layers are obliterated in spots and in others much contorted. To the north of Hedges yard in the R. R. cutting the clay is overlaid by five to six feet of sand and coarse stones, unstratified. Following up the track on the left side just beyond the crossing of the road from Canterbury to New Windsor the embankment of sand and coarse gravel is cross-stratified, being a portion of the delta of Moodna River. The character of this embankment changes after about 400 feet to unstratified drift, containing bowlders. This underlies the delta material. The upper terrace at Cornwall is underlain by bowlder drift.

Its structure is well shown along the track at Cornwall. Clay was observed in a meadow opposite the Roman Catholic church; it was exposed in digging drainage trenches. Near this locality, but a little nearer the river, were found several mastodon bones.

At Jones' Point there was formerly a small deposit of clay, but it has been entirely worked out.

Haverstraw has three terraces, viz.: At 20, 60 and 100 feet. The clay so far as known is only found underlying the two lower ones; the upper one being underlain by drift and delta deposits.

There is a deposit of clay at Stony Point forming a portion of the 20-foot terrace. The upper layers of clay are in places

loamy and undulating. Over the clay is a mass of unstratified material from two to eight feet thick and the upper surface of the clay is uneven. The overlying unstratified material is a coarse sand full of cobblestones, of gneiss, schist and granite, all of them rounded but not scratched. On the hillside to the west of this deposit is a large, isolated bowlder of granite. The upper terrace at Stony Point is about 75 feet higher than the station level; a portion of this terrace remains about one eighth mile north of Stony Point station on the west side of the track. On the west side of the track where it crosses Cedar Pond brook the delta structure is observable in the embankment, the upper portion of which consists of coarse sand, pebbles and cobblestones which are mostly of gneiss. The lower layers exposed at this point are quite argillaceous. A short distance below the West Haverstraw station and some 500 feet west of the track, an excavation had been made for tempering material. It exposes a fine yellowish cross-stratified sand overlain by several feet of coarse sand and cobblestones.

In T. Malley's clay bank along the shore on the north side of Grassy Point, the clay is not found above tide level and is overlaid by three to four feet of fine gravel. To the northeast of P. Brophy's yard is the remnant of a terrace. It is composed of obscurely cross-stratified sand and gravel, overlaid by a few feet of loamy clay, very thinly stratified and the layers wavy. There is a bowlder of norite in this bank; there are also cobblestones of diorite, gneiss and red sandstone. About 600 feet to the west of the yard of D. Fowler Jr. and Washburn the clay is being excavated in the terrace escarpment which is here 45 to 50 feet high. It is mostly blue, thinly stratified and overlain by obscurely stratified gravel and sand. In this excavation was a small ice-scratched bowlder which had been found in the clay. At J. Brennan's yard the clay is overlain by two to three feet of fine sand, and on this is a layer of indistinctly stratified fine gravel six to seven feet thick, with a covering of one foot of soil. The terrace at this point is about 50 feet high. Cobbles one to two feet in diameter of granite, gneiss and pegmatite were found in this bank. Further south at Peck's yard, several bowlders of granite, limestone and sandstone were found in the clay. Those seen were in the lower portion of the bed but I was told that several had been found in the upper portion.

Along the river behind the yards of the Excelsior and Diamond Brick Co. most of the overlying material has been removed by stripping, but judging from what is left it must have been 10 to 15 feet thick. South of Haverstraw the contact of the clay with the underlying drift can be observed, the clay thinning out as it approaches the hill. Some two miles south from Haverstraw, and half way between the stations of Ivy Leaf and Thiells on the New York & New Jersey R. R. in the valley of Ivory Creek, is a basin-shaped deposit of clay belonging to E. W. Christie. It is not over 15 feet thick as determined by boring, and has a slightly elliptical outline. The valley in which it lies is full of glacial material, and contains numerous kames, whose axes lie parallel to the direction of the valley. The clay is underlain by drift material containing bowlders of quartzite, calciferous sandrock, granite, sandstone, gneiss and schist. Over the clay is one to two feet of sand containing large ice-scratched stones of quartzite, gneiss and schist. This clay deposit was probably formed in a small lake. If it were a portion of the Hudson River estuary deposits, it would indicate a much greater submergence than that of 100 feet, supposed for this region, for this locality is 250 feet above the level of the Hudson River. On either side of the track at Thiells are probably remnants of a terrace.

The clay bank of the Anchor Brick Co. at Croton Landing, is elliptical in outline and lies on a bed of granite, gneiss, schist, and white crystalline limestone pebbles, cemented together by clay, covered with limonite. Large pebbles are scattered through the clay, the layers of which are undulating, conforming to the shape of the underlying surface. Over the clay is four or five feet of gravel and sand. South of this yard an excavation has been made under the terrace for obtaining gravel, exposing a section of Croton delta. Projecting up into it is a mass of bowlder-till.

About the middle of Croton Point are the clay-pits of the Underhill Brick Co. Their clay is overlain by the sandy beds of Croton delta. The material composing it was evidently derived from the crystalline rocks of the surrounding country. It is often micaceous and of a yellow color. Scattered through this sand are great numbers of botryoidal sand concretions, some

of them forming masses six feet long and three to four feet wide. They show the layers of deposition of the sand.

The clay at Cruger's, Montrose and Verplank lies in hollows in the rock, being as much as 50 feet thick in some places. At Cruger's it is overlain by a few feet of loam; at Montrose by stratified sand, varying in depth from five to 20 feet, according to borings made. Along the Hudson River R. R. track below Montrose, at Morton's yard, the clay is overlain by from eight to 10 feet of fine gravel, and cross stratified sand of a dark gray or black color. The materials composing it are, to a great extent, ground up crystalline rocks. The same material covers the clay at McConnell and O'Brien's bank. At the clay beds of of the Hudson River Brick Co. at Verplank, the clay is covered by yellowish sand and fine dark-colored gravel; usually they are unstratified, but in a few spots show cross-bedding.

A short distance below Peekskill, at Bonner & Cole's yard, is a remnant of a 20-foot terrace. There is here a deposit of clay not extending more than four feet above tide, and overlain by an unstratified layer five feet thick, of coarse sand and cobble-stones, mostly gneiss.

From Storm King station to Dutchess Junction there is a stretch of terrace, which extends back to the foot of Breakneck and Fishkill Mts. The maximum height of it is 210 feet. Various firms are digging clay in the terrace escarpment the greater part of its length. A well of 65 feet sunk at Aldridge's yard from tide level still showed clay, and adding to this 65 feet of clay above the river level, gives us a thickness of 130 feet at this point. The character and thickness of the overlying material varies somewhat. To the rear of Timoney's yard some 700 feet, the terrace has been excavated to a depth of 30 feet, exposing a mass of coarse sand, gravel and cobblestones, mostly granites, gneisses and schists. One portion of it is stratified, and at the base of the excavation at one point yellow clay has been found. At Timoney's yard there is one or two feet of loam overlying the clay and a growth of brush covers the terrace. At Van Buren's yard the upper layers of clay alternate with layers of sand; the upper six feet of the terrace at this point is gravel, the pebbles of it being mostly granite and gneisses. At Aldridge's yard the clay is covered by six to eight feet of unstratified gravel and sand, while at another

spot on top of his bank are 12 to 15 feet of fine yellow sand; which shows no stratification. The upper layers of Barnacue and Dow's clay are like those at Van Buren's, but covered by four feet of sand and over this in places six to eight feet of coarse gravel. Nothing is known of the underlying material of these yards.

The whole of Denning's Point is covered with a fine stratified yellowish sand. The clay, which lies at the base of the point, has a thin covering of loam, and the upper layers are somewhat wrinkled.

There is another stretch of terrace, similar to that below Dutchess Junction and of the same height, extending from one half mile above Fishkill to Low Point. At most places the clay is covered by a few feet of loamy soil. Several bowlders have been found in the clay at Brockway's yard. Several feet of loam overlie the clay at Lahey's, Brockway's and Dinan and Butler's yards. At J. V. Meade's yard a short distance below Low Point, the clay is covered by about three feet of sand, faintly stratified, and above this six to eight feet of unstratified material; coarse sand, pebbles and cobblestones, some of them 18 inches in diameter. Most of them are Archean rocks, but there are also fragments of shale, limestone, sandstone and a few of them contained Palæozoic fossils.

About 1,000 feet south of Meade's yard is a gravel bank eight to 15 feet thick of material similar to that overlying the clay in Meade's bank. At the base of this embankment in a few spots yellowish clay overlaid by stratified sand has been struck.

The following sections are those of wells bored at Rhinebeck.

On the land of Robert Duckley:

| | |
|---|---|
| Soil and yellow clay | 10 feet |
| Blue clay | 82 " |
| Rock | .... |
| Total thickness | 92 " |

On T. Reed's property:

| | |
|---|---|
| Soil and yellow clay | 20 feet |
| Quicksand | 100 " |
| Hardpan | .... |
| Total thickness | 120 " |

On J. O'Brien's property:

| | |
|---|---|
| Clay | 20 feet |
| Quicksand | 25 " |
| Hardpan | 2 " |
| Gravel | .... |
| Total thickness | 47 " |

The clay deposits of Hudson, Stockport and Stuyvesant are like those at Coeymans Landing, being overlaid in most places by a few feet of loam and underlain by dark sand and gravel. At Stockport two ice-scratched bowlders were found in the clay; one of them three feet in diameter, the other three times as large. To the north of Brousseau's yard at Stuyvesant the surface material is stratified sand, 15 feet of it being exposed thus far.

The delta deposits of the streams tributary to the Hudson River are extremely interesting. They give us an idea of the size of the rivers flowing into the Hudson Valley when it formed an estuary, and also indicate the amount of depression which took place at those localities. All three portions of a delta may be observed in the ancient deltas on the Hudson; they are the thin layers of loamy clay which form the secondary alluvial cone of the delta, the cross-stratified sand and gravel and the overlying unassorted material. This latter was observed at Haverstraw, New Windsor, Low Point and Dutchess Junction.

The following streams between New York and Poughkeepsie have formed delta deposits; (as noted by Dr. Merrill.*) Wappinger Creek, New Hamburg; Fishkill Creek; Indian Creek, Cold Spring; Peekskill; Croton River; Pocantico River, Tarrytown; Sawmill River, Yonkers; Tibbitt's Brook, Van Cortland; Minisceongo Creek, Haverstraw; Cedar Pond Brook, Haverstraw; Moodna River, Cornwall; and Quassaic Creek, Newburg. At the present day but traces of these deposits remain, and the streams which formed them have cut down through them below tide-level. Dr. Merrill thinks it highly probable that these deltas once filled a large portion of the valley in the Highlands. At Roseton, as already mentioned, there is a deposit which may have come from the delta of Wappinger Creek. Also at Jones' Point opposite Peekskill there is a terrace composed of transported

*Amer. Jour. Sci. iii, XLI, June 1891.

material, which Dr. Merrill for a while regarded as a portion of Peek's Kill delta; the size of the pebbles composing it however caused him to give up this view. There is however in the upper portion of the terrace, a layer of unassorted material which is slightly separated from the rest; also at the south end of the terrace, a portion of thinly and obscurely stratified loamy clay, which may have formed a portion of the secondary cone of this delta. At Croton, Haverstraw and Cornwall, also at New Windsor, the clay is overlain by delta material, and where this occurs, specially at Croton, the upper limit of the clay is comparatively low, it having probably been eroded to a certain extent by the river entering the estuary at that point, and again it is not likely that very much clay would be deposited around the mouth of the river on account of the current. This may have been the case below Peekskill.

In general the upper limit of the clay increases northward as does the terrace level. To illustrate this point we have the following altitudes:

| | |
|---|---|
| East side. | |
| Croton | 100 |
| Peekskill | 120 |
| Fishkill | 205 |
| West side. | |
| Haverstraw | 100 |
| West Point | 185 |
| Cornwall | 200 |
| Newburg | 205 |
| Port Ewen | 207 |
| Schenectady | 360 |

These measurements apply, of course, to the upper terrace, which can be traced along many portions of the river.*

An examination of the above figures and the distances between the points mentioned indicate an interesting fact. Between New York and Peekskill, a distance of 45 miles, the terrace rises 40 feet, or eight ninths of a foot per mile. From Peekskill to West Point the rise is eight feet per mile. From West Point to Newburg the terraces ascend two and one half feet, and from Newburg to Albany about five twelfths of a foot per mile. From the above it would seem that the uplift from New York to Albany

*For detailed statement of terrace altitudes, see H. Ries, Trans. N. Y. Acad. Sci., Nov., 1891

did not increase uniformly, but was slightly greater along the axis of the Highlands. To determine this point definitely requires a large number of accurate terrace measurements. The following are the number of terraces noticed at the different localities:

| | |
|---|---|
| Athens | 2 |
| Port Ewen | 2 |
| Cornwall | 2 |
| Haverstraw | 2 |
| Stony Point | 3 |
| Peekskill | 1 and 2 |
| Fishkill | 2 |
| Storm King | 2 |
| Schodack | 2 |

The shore-line of the upper terrace is generally some distance back from the river. In fact, as we go up the river, especially above Port Ewen, the shore-line recedes. At Port Ewen the terrace is 207 feet, but it is fully 225 feet at the base of Hussey Mt, which was an island in the estuary. The terrace extends up the Walkill valley several miles.* It seems not improbable that a shore line of this Quaternary deposit will be found along the base of the Catskill Mts, or not far from there. At Coeymans Landing the terrace is 140 feet, and it rises to 177 feet at the W. S. R. R. station, about a mile from the river, then a hill hides the further continuation of it from view.

From Catskill up to Albany the terrace at most points is very wide. At Coxsackie it extends behind the hill to the south of the town, and comes down along Murder Creek to Athens. From Albany an alluvial plain, belonging to this formation, spreads westward, reaching a height of 360 feet near Schenectady. The surface of these terraces is usually a loamy soil of much agricultural value.

Following up Croton River as far as Croton Lake, remnants of terraces are seen at various points, their height above the river bed decreasing as we recede from the Hudson. The majority of these detached pieces seem to belong to a terrace formed at the same time as the 100-foot one at Croton Landing. There are at a few places traces of a second and lower terrace, and besides this a third one, being formed by the river during its floods at the present day.

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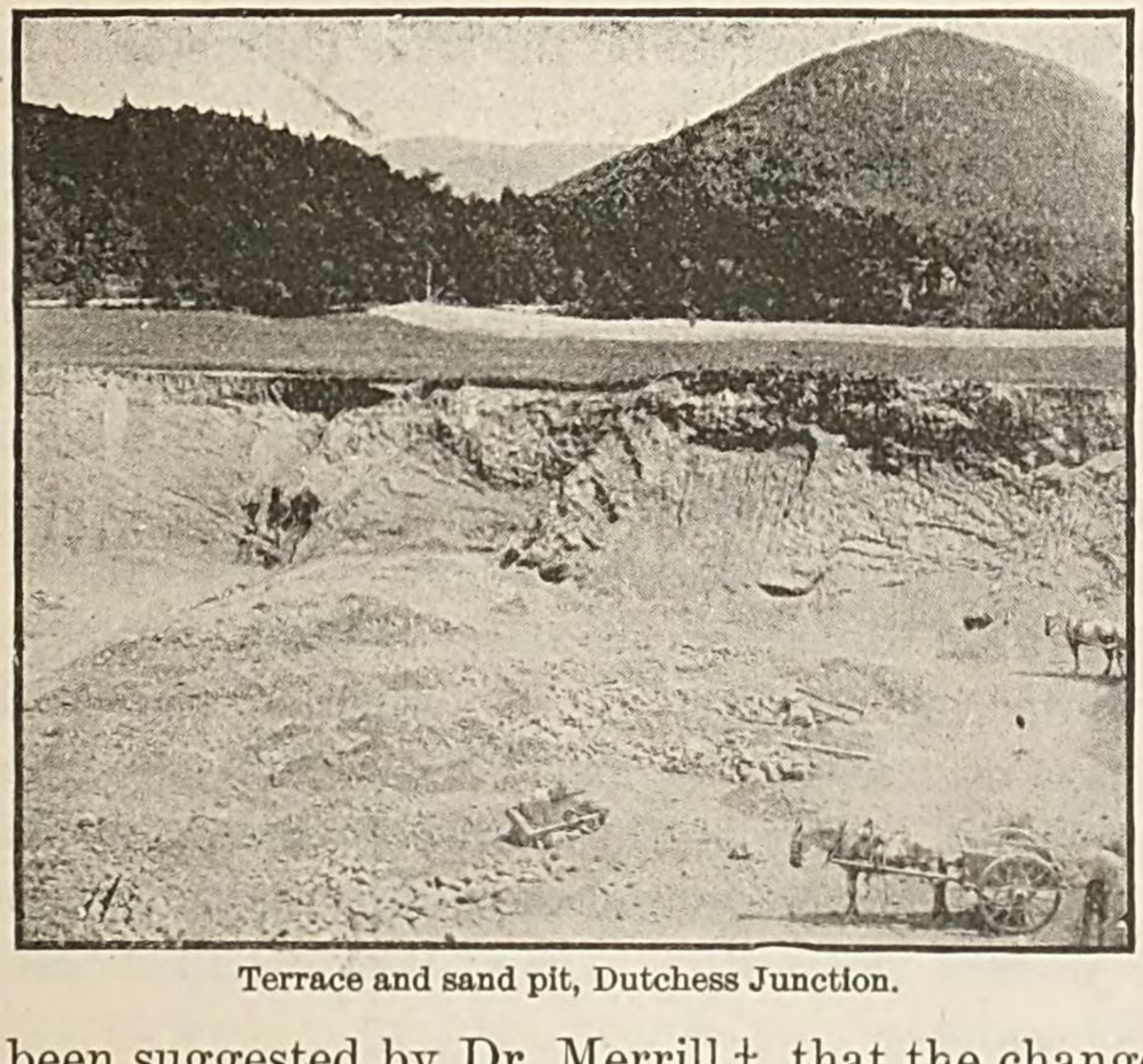
* Mather, Geol. 1st Dist. N. Y., p. 131.

From the facts as observed, quoted above, the following may be deduced. That during the retreat of the ice sheet from the Hudson valley the glacial streams deposited as kames a great amount of ground up material, principally shale; the material found underlying the clays along the upper portions of the valley.

That subsequent to the retreat of the glacier there was a depression of the land, which, according to Dr. Merrill,* amounted to 80 feet at New York city and near Schenectady to about 360 feet.

During this period a great amount of plastic clay was deposited produced by glacial attrition of the shales and limestones, the latter no doubt giving to it the marly character and influencing its color.

The upper portion of the clay is more siliceous and overlying it is an extensive deposit of sand, indicating a change in the nature of the material washed into the estuary. During the period of submergence much of the siliceous matter washed into the estuary was deposited at the mouths of the tributary streams to form deltas.



Terrace and sand pit, Dutchess Junction.

It has been suggested by Dr. Merrill† that the change in the estuary deposits from clay to sand might be due to the exposure

* Amer. Jour. Sci., June, 1891.
† Amer. Jour. Sci., June, 1891.

by elevation of an area of land around the basin, which would afford more siliceous matter.

An elevation would be accompanied by an acceleration of the streams, and much of the siliceous matter transported by them would be carried farther out into the estuary and spread over its bottom, while the finer clayey sediment would be carried out to sea. A readvance of the ice, it would seem, would likewise cause an acceleration of the streams, and with the results stated above.

To account for the isolated bowlders in the clay it seems highly probable that icebergs or icefloes having stones and dirt imprisoned within their mass detached themselves from the retreating glacier, and, floating down the estuary to the sea, dropped their burdens.

The unstratified material found with it and in some cases overlying the stratified delta deposits is a matter of interest as concerns its origin. Three things may be noticed regarding it.

1. The material is sand, pebbles and cobblestones lying mixed together without any separation of the coarse from the fine.*

2 The pebbles and stone are rounded and do not show any scratches.

3 The materials are mostly of the same character as the rocks of the vicinity.

Now as the land rose from its submergence the velocity and with it the transporting power of the streams would increase, washing down quantities of large stones and gravel. Dr. Merrill considers that a rapid flow of water took place down through the Hudson Valley in the late Quaternary. This water must have come down through the valleys of the tributary streams, having a much greater velocity in their valleys than it would have after it turned into the Hudson Valley, and the checking of its velocity as it reached the Hudson would cause the deposition of the greater part of its load. A large stream rushing down the valley of the Fishkill would drop its burden specially below it, where we find them heaviest as the flow of the water was toward the south. Again, Peek's Kill would behave in a similar manner.

A curious and interesting phenomenon is the crumpling of the clay at many localities. This disturbance often extends through-

* The only locality where stratification was observable was at Timoney's yard near Dutchess Junction

out the section, and has been caused by slips or pressure from above, as when the clay is covered by a thick delta deposit. Prof. R. P. Whitfield has told the writer of instances where the clay layers had been disturbed to a depth of several feet from the surface by the weight of bowlders and large trees.

In many instances there occurs a crumpled strip of clay between layers which are entirely undisturbed; this has been actually observed by the writer to have been caused by slipping of the clay.

*Clay concretions.*— These are of common occurrence, especially in the yellow clay. They are of varying form and size. Many of them have a cylindrical hole in the center, which is lined with carbonaceous material. The flat concretions are found parallel to the layers of the clay, and in many instances at a depth from the surface to which the roots penetrate.

Those found at a greater depth did not have the central cylindrical cavity. They are very abundant in the yellow clay at Haverstraw. Roots penetrating the clay at this locality were surrounded by lumps of clay in the form of concentric rings. These might seem to indicate the method of formation described by Prof. J. D. Dana (Manual of Geol., p. 628). Again in the yellow clay near the surface at Coxsackie were found some forms which were similar in appearance to what Dr J. I. Northrup has described as rhizomorphs.* They may be due to the roots which penetrate the clay, absorbing water from it and rejecting the contained lime, which deposits itself around the root forming the hard rhizomorph. Their interior structure was crystalline.

Another form of concretion is found in the delta sands at Croton Point. It consists of botryoidal masses of sand, cemented by oxide of iron. Some of them show the layers of deposition of the sand. The concretions are usually small, but one mass was noticed fully six feet long and four feet wide.

Concerning the origin of these concretions various opinions are expressed by different geologists.

Organic remains are extremely rare in these clays. The writer has discovered sponge spicules, probably referable to *Hyalonema* or an allied genus, and which are figured. The following

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* Trans. N. Y. Acad. Sci., Oct. 13, 1890.

diatoms were also found: *Navicula Gruendleri*, A. S.; *Navicula permagna*, Edw. (fragments); *Melosira granulata* (Ehr.) Ralfs; *Nitzshia granulata*, Grun. All fresh water species. At Croton Landing a number of impressions were found in the blue clay and these on being submitted to Prof. Hall were pronounced to be worm tracks. Mather in his report* mentions the finding of leaves in the clay beds back of the medical college at Albany, and states that they resemble those of an aquatic plant.

### The Clays of the Champlain Valley†

The clays of the Champlain valley are estuary formations and of the same age as the Hudson River clays. They underlie terraces along the lake which have been elevated to a height of 393 feet above sea level. These terraces may be traced almost continuously from Whitehall, at the head of Lake Champlain, to the northern end of the lake and beyond it, but on account of the extensive erosion which has taken place they are usually narrow, and it is only at sheltered points like Port Kent and Beauport that they become specially prominent. The section involved is yellowish brown sand, yellowish brown clay and stiff blue clay, the latter being rather calcareous. The upper clay is somewhat siliceous, and its coloring is due to the weathering of the lower layer. This formation has a thickness of about 15 feet, but sometimes, as at Burlington, it reaches a thickness of 100 feet. Isolated bowlders are occasionally found in the clays, and are considered by Emmons to have been dropped there by icebergs. The clays are usually horizontally stratified, and contortions of the layers are extremely rare. Numerous fossils have been found in the overlying sands, among them being *Saxicava rugosa* and *Tellina groenlandica*, which are very common; *Tritonium anglicum*, *Tritonium fornicatum*, *Mytilus edulis*, *Pecten islandcus*, *Mya truncata*, *M. arenaria*, *Nucula portlandica;* the skeleton of a whale has also been found in these deposits.**

Openings have been made in them for the purpose of obtaining brick clays at Plattsburg and a few other localities, but owing to the lateness of the season when I visited them information was hard to obtain.

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* Geol. 1st, Dist. N. Y., p. 123.

†Compiled largely from Emmons Report, Geol. N. Y. 2nd Dist.

** The writer has found one species of diatom belonging to the genus *Diatoma* in the clay from Plattsburg.

## Long Island Clays

Long Island is made up of a series of sands, gravels and clays, which form two parallel ranges of hills in the northern half of the island, while the southern half is a flat plain. The most southern of the ranges represents the limit of the drift.*

The clay beds are exposed along the north shore of the island and at several points along the main line of the Long Island railroad. In describing them I have gone east along the north shore and come back through the center of the island.

In a paper on the geology of Long Island, (previously cited) Dr. F. J. H. Merrill describes in detail the formations exposed on the island, and mentions the insufficiency of data necessary to afford definite conclusions concerning the sequence of geological events. Examinations of the various clay outcrops on the island made since show that eight years has made considerable changes; permitting the collection of additional data and obliterating many localities described by him. With the exception of four similar deposits on the north shore, all the clay beds as exposed at the brick yards are rather unique in appearance.

The most western clay outcrop on Long Island, of which the writer has any knowledge, is on Elm Point near Great Neck.‡ There is here a bed of stoneware clay over 30 feet thick and overlain by 15 to 20 feet of yellow gravel and drift. The clay is dark gray and contains streaks of lignite in a good state of preservation. In appearance the clay resembles the Cretaceous ones of New Jersey and will doubtless prove to be of the same age. The overlying yellow gravel contains sandstone concretions and also sandstone fragments containing Cretaceous leaves.**

There is an outcrop of clay at Glen Cove on the east shore of Hempstead Harbor and at the mouth of Mosquito Inlet. This has long been considered of Cretaceous age from the plant remains found† in sandstone fragments embedded in the clay. The layers of the latter are blue, red, black and yellow, and dip northeast 10°–15°. Near this locality and on the south shore of Mosquito Inlet is an outcrop of pink clay, belonging to Carpenter Bros. and used for fire-brick and stoneware. Dipping under it to the

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* For a detailed account of the topography of Long Island see Mather, Geology of New York (1st Dist.) 1843; W. Upham, A. J. S. 111, 18.; F. J. H. Merrill, Geology of Long Island, Ann. N Y Acad. Sci., 1884.

‡ H. Ries. Notes on the clays of New York State.—Trans. N. Y. Acad. Sci., XII.

** C L Pollard, Note on Cretaceous leaves from Elm Pt., L. I.—Trans. N. Y. Acad. Sci., XIII.

† A. Hollick, Trans. N. Y. Acad. Sci., XII.

north at an angle of 30° is a bed of alternating layers of quartz pebbles and clay. The pebbles crush easily to a white powder. Associated with this clay is a bed of kaolin, but the exact relations of the two deposits are not known. Kaolin also crops out from under the gravels on the west shore of Hempstead Harbor. Carpenter's clay resembles that of Cretaceous age found on Staten Island, but its age has yet to be proven. The sandstone fragments found in the clay across the inlet are found along the shore of it to Carpenter's clay, but none are found in it. Dr. Merrill has found plant remains in this clay, but they were not sufficiently well preserved for identification. (See paper previously cited.) A microscopic examination of the clay revealed the presence of the following diatoms; all freshwater forms.

*Melosira granulata* (Ehr.), Ralfs.
*Stephanodiscus Niagaræ* (Ehr.),
*Diatoma hyemale* (?) K. B.

On Center Island in Oyster Bay we find the most western of a series of clay beds which bear a gréat similarity to each other. The others are on West Neck, at Fresh Pond and on Fisher's Island. The clay on Center Island consists of two kinds, a lower bluish clay and an upper brown sandy clay. Overlying this latter is a stratified sand. The layers of clay undulate in several directions. Dr. Merrill mentions the occurrence, one mile north of this clay pit, of a bed of white fire clay at a depth of 25 feet under the drift and sand. The only organism thus far met in this clay is one species of diatom, viz.: *Stephanodiscus Niagaræ*; and a curious spiny hair.

At Jones' brick yard on the east shore of Cold Spring Harbor is a thick deposit of clay. The lower portion is tough and contains little sand. The upper portion is much more sandy and of a brown color. The clay bank is over 100 feet in height and the layers have crumpled on a large scale by the pressure of the advancing ice sheet. A layer of diatomaceous clay occurs in th upper portion of the clay bank, and its position is shown in the following section given by Merrill: (l. c.)

| | |
|---|---|
| "Till" and stratified drift | 10 feet. |
| Quartz gravel | 45 " |
| Red and blue "loam" or sandy clay | 20 " |
| Diatomaceous earth | 3 " |

| | |
|---|---|
| Yellow and red stratified sand | 20 feet. |
| Red plastic clay | 20 " |
| Brown plastic clay | 25 " |
| Total | 143 |

"The bed of diatomaceous earth is of undetermined extent, and appears to be replaced a little to the east by a blue clay, which, however, contains some diatoms. It is undoubtedly equivalent to the bed of ochre which overlies the sand throughout the remainder of the section."

The following diatoms, all fresh-water species, occur in it :

*Melosira granulata* (Ehr.) Ralfs.
*Stephanodiscus Niagaræ* (Ehr.)
*Epithemia turgida* (Ehr.) Kutz.
*Encyonema ventricosum*, Kutz.
*Cymbella delicatula*, Kutz.
*Cymbella cuspidata*, Kutz.
*Navicula viridis*, Kutz.
" *coconeiformis*, Greg.
" *major*, Kutz.
" *varians*, Greg.
" *lata*, Breb.
*Eunotia monodon*, Ehr.
*Gomphonema capitatum*, Ehr.
*Stauroneis Phœnecenteron*, Ehr.
*Fragilaria construans*, Grun.
*Synedra affinis*, K. B.
*Campyloneis Grevillei* var. *Regalis*.
*Triceratium trifoliatium*.

The *Melosira* and *Stephanodiscus* are present in countless numbers. Only two specimens were found of the *Triceratium*, and Dr. D. B. Ward, of Poughkeepsie, who has also given me much aid in the identification of my material, informs me that this species is very common in the diatomaceous earth from Wellington, New Zealand, but he has never heard of its occurrence before in America.* Sponge spicules are not uncommon in Lloyd's Neck diatomaceous earth, and several forms are figured. Samples of the red and brown clay from the section given above were examined, but no organic remains were found in them.

* Since this report was sent to press the writer has been informed of the discovery by Mr. Lewis Woolman of this same species in certain New Jersey deposits.

(Magnified 500 diameters, except Fig. 1, which is enlarged 250 diameters.)

FIGS. 1–13. Sponge spicules. Croton Point.

FIG. 14. *Melosira granulata* (Ehr.) Ralfs. Croton Point.

FIG. 15. *Navicula Gruendeleri*, A. S. Croton Point.

FIG. 16. *Diatoma* sp? Plattsburg.

FIG. 17. Diatom fragment from Croton Point.

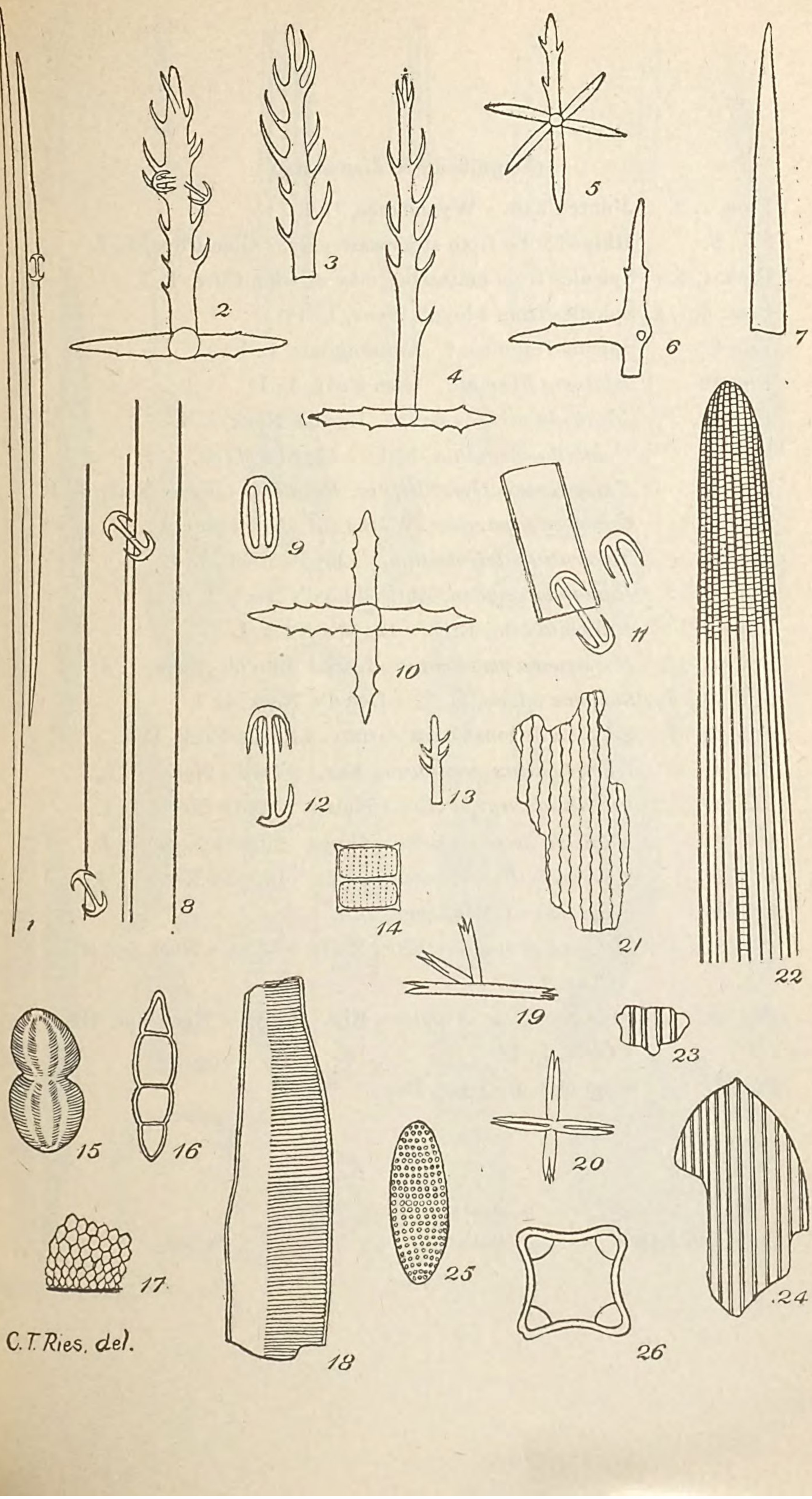
FIG. 18. *Navicula permagna*, Edw. Croton Point.

FIGS. 19, 20. Sponge spicules. Kreischerville, S. I.

FIGS. 21, 22, 23, 24. From clay at Verplank.

FIG. 25. *Nitszchia granulata*, Grun. Croton Point.

FIG. 26. From clay at Croton Point.


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(Magnified 500 diameters.)

FIGS. 1, 2. Jointed hair. Wyandance, L. I.

FIG. 3. Ridged tube from stoneware clay. Glen Cove, L. I.

FIGS. 4, 5. Spicules from cretaceous clay at Glen Cove, L. I.

FIGS. 6, 7, 8. Spicules from Lloyd's Neck, L. I.

FIG. 9. Spicule fragment? Farmingdale, L. I.

FIG. 10. *Diatoma hyemale.* Glen Cove, L. I.

FIG. 11. *Navicula viridis*, Kutz. Lloyd's Neck, L. I.

FIG. 12. *Cymbella cuspidata*, Kutz. Lloyd's Neck, L. I.

FIG. 13. *Campyloneis Grevillei*, var. *Regalis.* Lloyd's Neck, L. I.

FIG. 14. *Cocconema parvum*, W. Smith. Northport, L. I.

FIG. 15. *Triceratium trifoliatum.* Lloyd's Neck, L. I.

FIG. 16. *Eunotia monodon*, Ehr. Lloyd's Neck, L. I.

FIG. 17. *Navicula lata*, Breb. Lloyd's Neck, L. I.

FIG. 18. *Encyonema ventricosum*, Kutz. Lloyd's Neck, L. I.

FIG. 19. *Synedra affinis*, K. B. Lloyd's Neck, L. I.

FIG. 20. *Fragilaria construans*, Grun. Lloyd's Neck, L. I.

FIG. 21. *Gomphonema capitatum*, Ehr. Lloyd's Neck, L. L.

FIG. 22. *Epithema turgida* (Ehr.) Kutz. Lloyd's Neck, L. I.

FIG. 23. *Navicula cocconeiformis*, Greg. Lloyd's Neck, L. I.

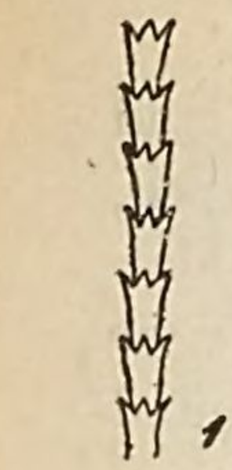
FIG. 24. *Stauroneis Phœnecenteron*, Ehr. Lloyd's Neck, L. I.

FIG. 25. From clay at Northport, L. I.

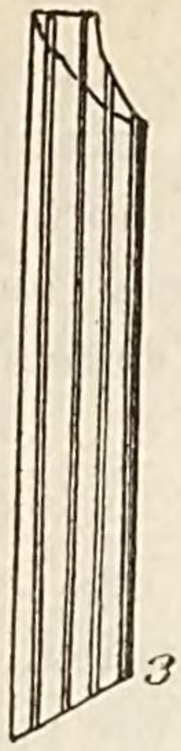
FIGS. 26, 27. *Melosira granulata* (Ehr.) Ralfs. Lloyd's Neck and Glen Cove, L. I.

FIG. 28. *Stephanodiscus Niagaræ*, Ehr. Lloyd's Neck and Glen Cove, L. I.

FIG. 29. From clay at Oyster Bay.


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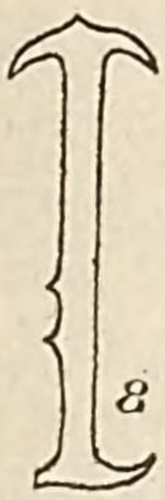

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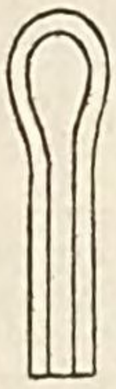

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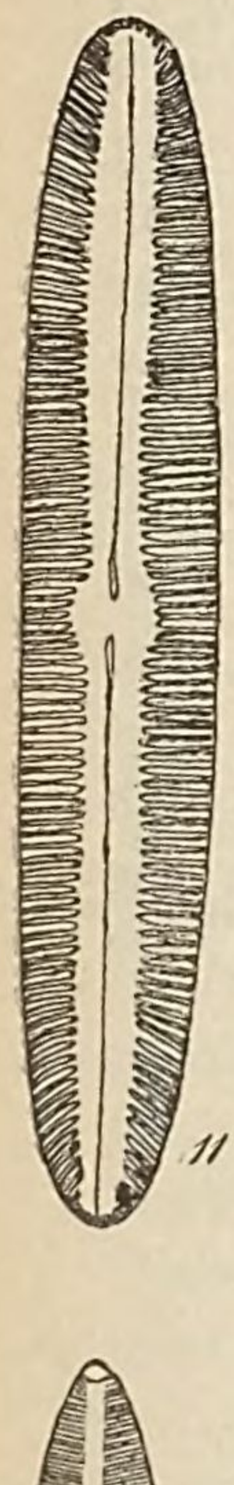

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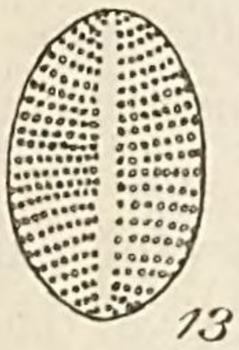

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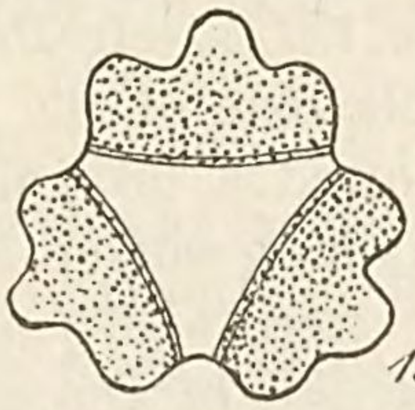

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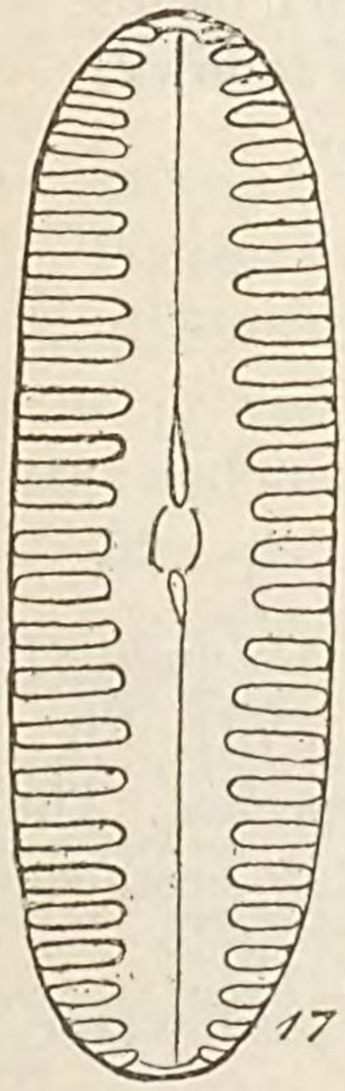

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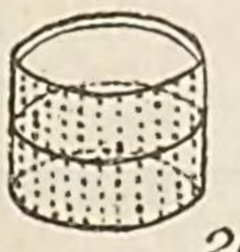

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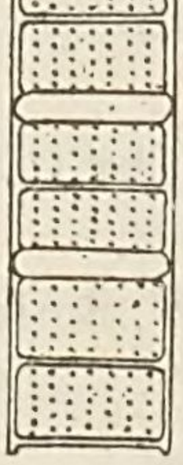

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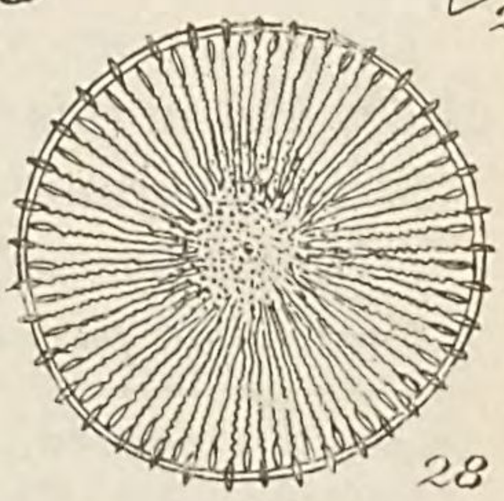

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Concretions are abundant in the clay on Center Island and West Neck. Those found at the latter locality are disc-shaped, while those found on Center Island are more or less botryoidal.

Silicified yellow gravel fossils have been found by the writer in the sands on West Neck,* and more were subsequently found in other localities by Mr. Hollick.†

On Little Neck, in Northport Bay, is an extensive deposit of stoneware clay and fire sand, which has been worked for a number of years. The clay is stratified, the layers being separated by laminæ of sand. In color the material varies from black to brown and yellow, and it becomes sandy in its upper portion. There is a dip of 15° S. E. due to a slipping of the clay bank. Overlying the clay is cross-bedded fine sand and gravel, the latter containing much coarse material near the surface. Very little till covers the whole. Much fine, white fire sand occurs in portions of the bank. A careful examination of the section showed a brownish-black seam of the clay, two feet thick, containing numerous fragments of plant remains, of which a number were sufficiently well preserved to determine the Cretaceous age of the clay beyond doubt. The species were identified for me by Mr. Hollick as follows:

*Protaeoides daphnogenoides*, Heer.
*Paliurus integrifolia*, Hollick.
*Laurus angusta*, Heer.
*Myrsine* sp.
*Williamsonia* sp.
*Celastrophyllum* sp.
*Paliurus* sp.

The latter resembles *Paliurus Columbi* (Heer); a Tertiary species (Fl. Foss, Arct. I, 122, pl. XVII, Fig. 2d,) but is much smaller and very probably a new species. The above species are the same as those found in the middle cretaceous clays of Staten Island, N. Y., and Perth Amboy, N. J.

Three species of diatoms, all fresh water forms, were also discovered in this clay.

*Melosira granulata*, (Ehr.) Ralfs.
*Diatoma hyemale*, K. B.
*Cocconema parvum*, W. Smith.

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*Trans N. Y. Acad. Sci., XII.
† Trans. N. Y. Acad. Sci. Vol. XIII.

The occurrence of these diatoms is a matter of great interest. While diatoms are abundant in the Tertiary, their only known occurrence in the Cretaceous, is the chalk* which is upper Cretaceous. This being the case, their occurrence at Northport extends the known geological range of diatoms.

At Fresh Pond the clay crops out along the shore for distance of half a mile. It is brownish and red in color, the red being more sandy. Sand and gravel overlies it, and at Sammis' yard the sand, which is stained by limonite, shows a fine anticlinal fold.

One of the most interesting clay banks is that on Fisher's Island. The clay is of a reddish color similar to that on West Neck and Center Island, and in its original condition was horizontally stratified and overlain by 20 to 30 feet of laminated sand. But the whole deposit has been disturbed by the ice sheet passing over it, and the layers have been much crumpled to a depth of about 30 feet, while below this they are undisturbed. The till overlying it is in places 30 feet thick and contains large bowlders.

Dr. Merrill mentions the presence on Gardiner's Island,† of extensive beds of brick clay together with their associated sand beds, (they are not being worked,) and notes the occurrence of a fossiliferous stratum.

Clay is also said to outcrop near Sag Harbor and around the shore of Hog Neck in Peconic Bay.

Between Southold and Greenport are several deposits of a red glacial clay which is being used for brick. The clay contains angular stone fragments and runs from 50 to 60 feet in thickness. About one and a half miles east of Southold is a bed of mottled blue pottery clay which has been used for a number of years in making flower pots. The depth of this deposit is not known.

At West Deer Park is a clay bank of unique appearance. In July 1892 the section showed

| | | |
|---|---|---|
| | Yellow gravel | 6 feet |
| Containing concretions | Flesh colored clay | 6 " |
| | Red clay | 1 " |
| | Black clay with pyrite | 4 " |
| | Black sandy clay | 4 " |
| | Red sandy clay | 3 " |
| | Total thickness | 20 " |

*Nicholson, Manual of Palaeontology, II. †Previously cited.

Lenticular masses of gray sand are sometimes found in the black clay. The black clay also contains furstules of *Melosira granulata*, (Ehr.) Ralfs, and numbers of a jointed yellowish brown hair, resembling those of a crustacean. The black clay burns to a white brick. About four miles west of this locality near Farmingdale the section in Myers' clay pit is

| | |
|---|---|
| Sand and gravel | 6 feet |
| Red sandy clay | 6 " |
| Yellow and red sand, wavy lamination | 2 " |
| Reddish yellow clay | 6 " |
| Reddish blue clay | 20 " |
| Micaceous sand, cross-bedded | .. " |
| Total thickness | 40 " |

About one-quarter mile south of Myers' brick yard is that of Stewart. The section at this locality (now obliterated) as given by Dr. Merrill is *

| | |
|---|---|
| Surface stratum yellow micaceous clay | 35 feet |
| Reddish and sandy clay | 5 " |
| Blue black sandy clay with nodules of white pyrites | 25 " |
| White sand | .. " |
| Total thickness | 65 " |

A local deposit of grayish blue sandy clay occurs at E. Williston. It varies in depth from six to 20 feet and is underlain by sand. On my last visit to this locality I found a number of stems and leaf fragments in the clay but none of them sufficiently well preserved for identification.

There is still some doubt as to the exact conditions under which the beds of clay and gravel which form the greater portion of Long Island were deposited, but it is probable that the clays represent shallow water marine deposits of Cretaceous and Tertiary age. The overlying sands and gravels have in most instances a cross-bedded structure, with a south dip, and were probably deposited by swift currents as stated by Dr. Merrill.

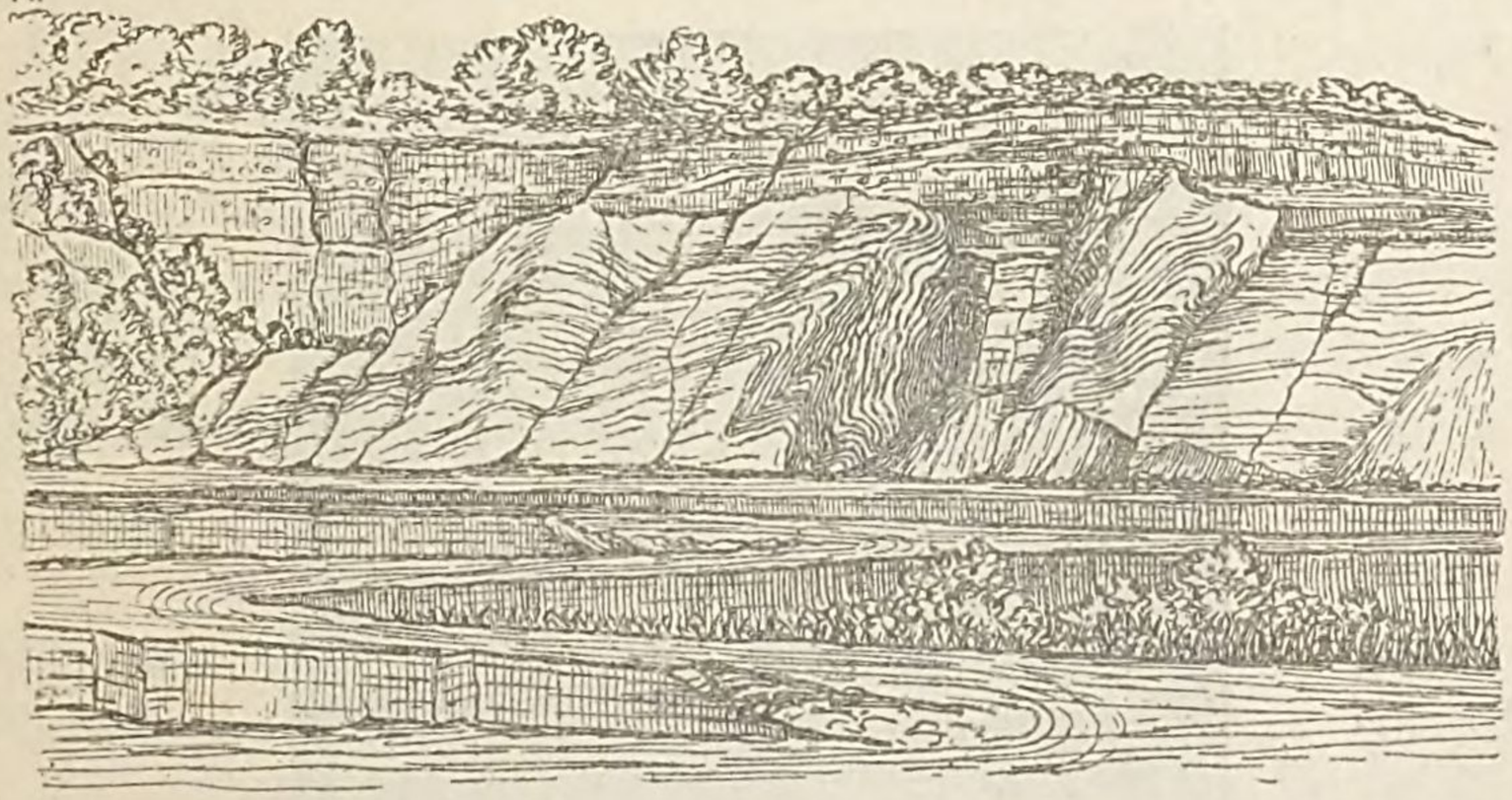
The age of the clays is still largely a matter of speculation, and will probably remain so in many cases unless palæontologic evidence is forthcoming. Those on Gardiner's Island are quite

* Geology of L. I., Ann. N. Y. Acad. of Sci., Nov. 1884.

recent, as shown by the contained fossils, and the clay on Little Neck near Northport is Cretaceous as previously noted. The proof of the age of the Glen Cove clay is not absolute.

Cretaceous leaves in fragments of ferruginous sandstone have been found along the north shore of Long Island from Great Neck to Montauk Point,* but they are usually much worn and scratched and have evidently been transported from some distant source. The clays at Center Island, West Neck, Fresh Pond and Fisher Island are very similar in appearance and composition, are very probably of the same age, possibly Tertiary,† but we lack palæontologic or stratigraphic evidence. At West Neck the clay underlies the yellow gravel and the latter is covered by the drift, so that is pre pleistocene.

The theory has been put forth that the Cretaceous formation on Long Island would be found north of a line joining the southern border of the Cretaceous formation of New Jersey and Martha's Vineyard,‡ and that outcrops south of this might be Tertiary; in view, however, of determining the clay at Little Neck near Northport to be Cretaceous. we must abandon this theory.

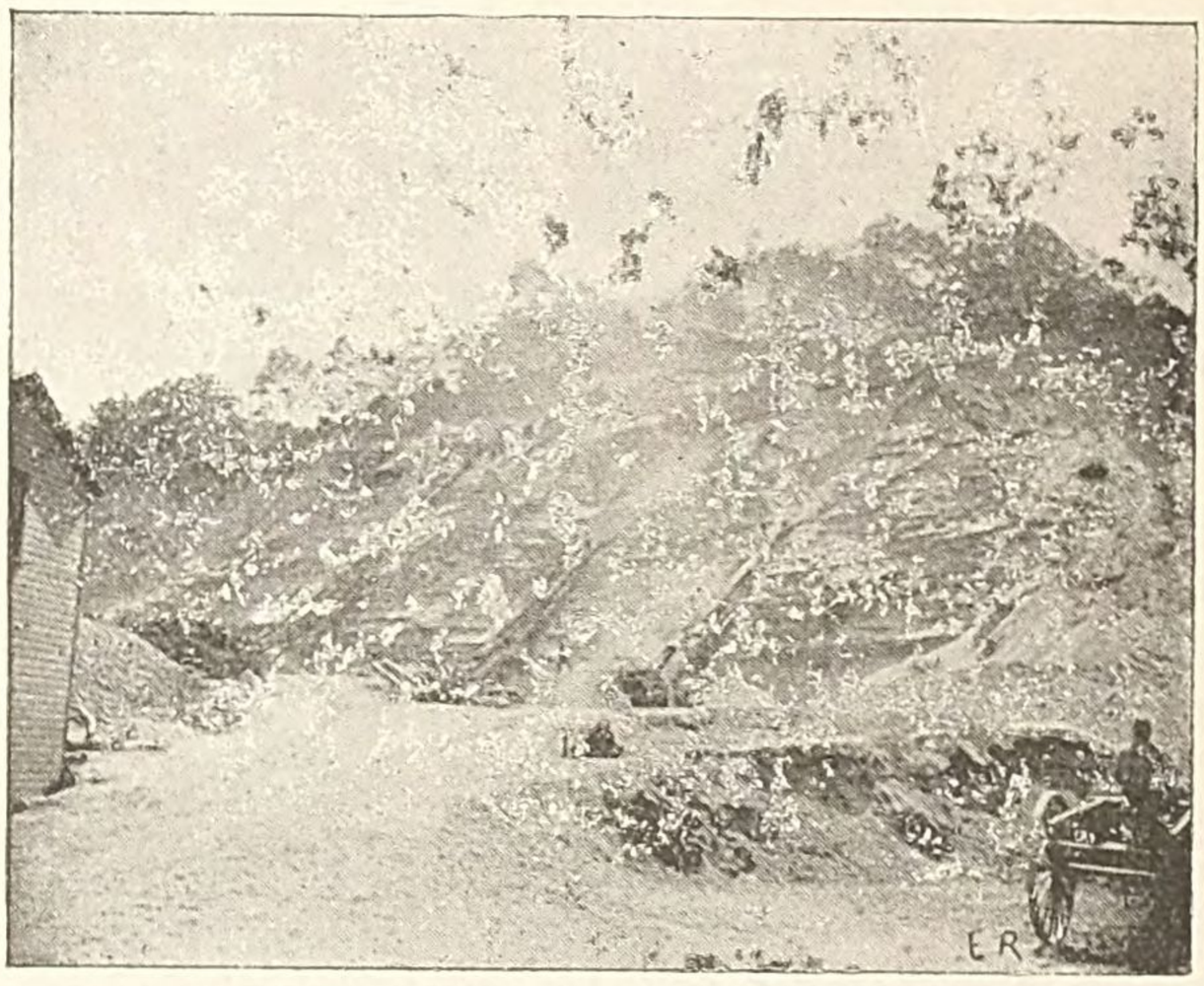



Folded clays, West Neck, L. I.

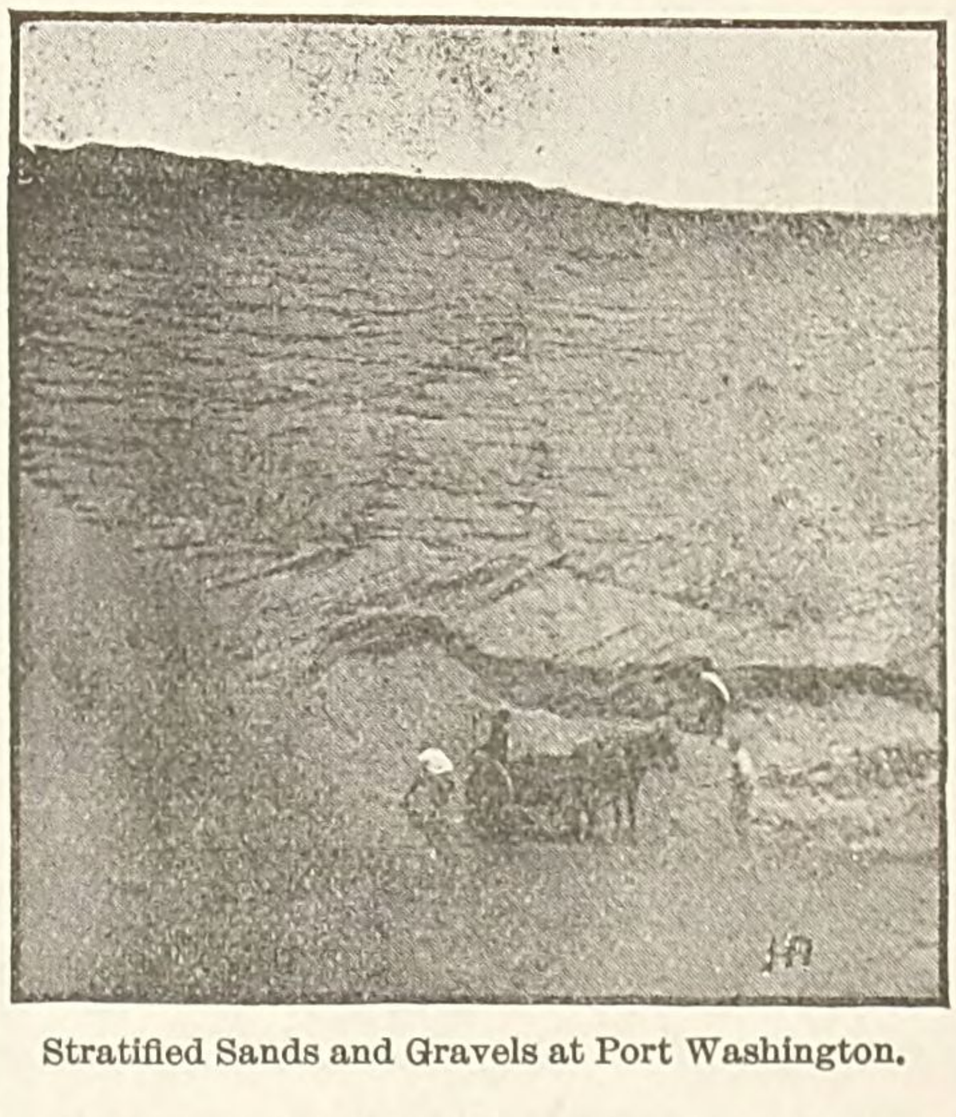
An interesting phenomenon is the tilting and crumpling of the strata on the north shore of Long Island. This disturbance is especially well shown on West Neck and was considered by Dr. Merrill to be due to the pressure of the advancing ice sheet,§ which excavated the deep narrow bays and pushed the

* A. Hollick, Notes on Geology of North Shore of Long Island, Trans. N. Y. Acad. Sci., XIII.
† This idea is also expressed by Dr. Merrill.
‡ A. Hollick, Notes on Geology of North Shore of Long Island, Trans. N. Y. Acad Sci. XIII.
§ Geology of Long Island, Ann. N. Y. Acad. Sci. 1884.

excavated material into high hills at their head. Dr. Merrill's views have been recently corroborated in a paper on "The deformation of portions of the Atlantic coast plain," by A. Hollick,* who, in disputing the possible orogenic origin of these



Sand and Gravel, West Shore of Hempstead Harbor.



Stratified Sands and Gravels at Port Washington.

folds, calls attention to the fact that they are found only along the line of the moraine, and that the beds are disturbed only to a certain depth. The disturbance is well shown at Glen Cove,

* Trans. N. Y. Acad. Sci., XIV.

West Neck, Fresh Pond and on Fisher's and Gardiner's islands. It is important, however, not to confound tilting of the layers, due to slipping, as is the case on Little Neck near Northport, with that produced by the ice-thrust.

Both Dana and Merrill consider Long Island Sound to be of preglacial origin; the former calls attention to a channel in the southern part of the sound, which probably was that of a river draining Connecticut in preglacial times, and which emptied into Peconic bay. The latter points to the absence of till along the north shore of Long Island where the sound is wide, as evidence of the fact that most of the drift was dropped into the sound by the ice in its passage across it.

On the other hand Hollick* considers that Long Island Sound was dry land until the glacial period, and that the continental glacier upon its arrival on the Connecticut shore plowed up the material from the space now occupied by the sound and pushed it ahead to form the range of hills along the northern part of Long Island. It seems to the writer however that the facts do not support this theory. If we suppose the northern range of hills to be composed of material pushed up out of the area now occupied by the sound, it should everywhere show signs of disturbance. This it does not do. The high hills of sand and gravel at Port Washington for example show no signs of disturbance.

Mention should be made of a yellow gravel formation. This is found almost everywhere on Long Island, and sections in the railway cuttings frequently show a thickness of 30 or 40 feet.

## Staten Island clays

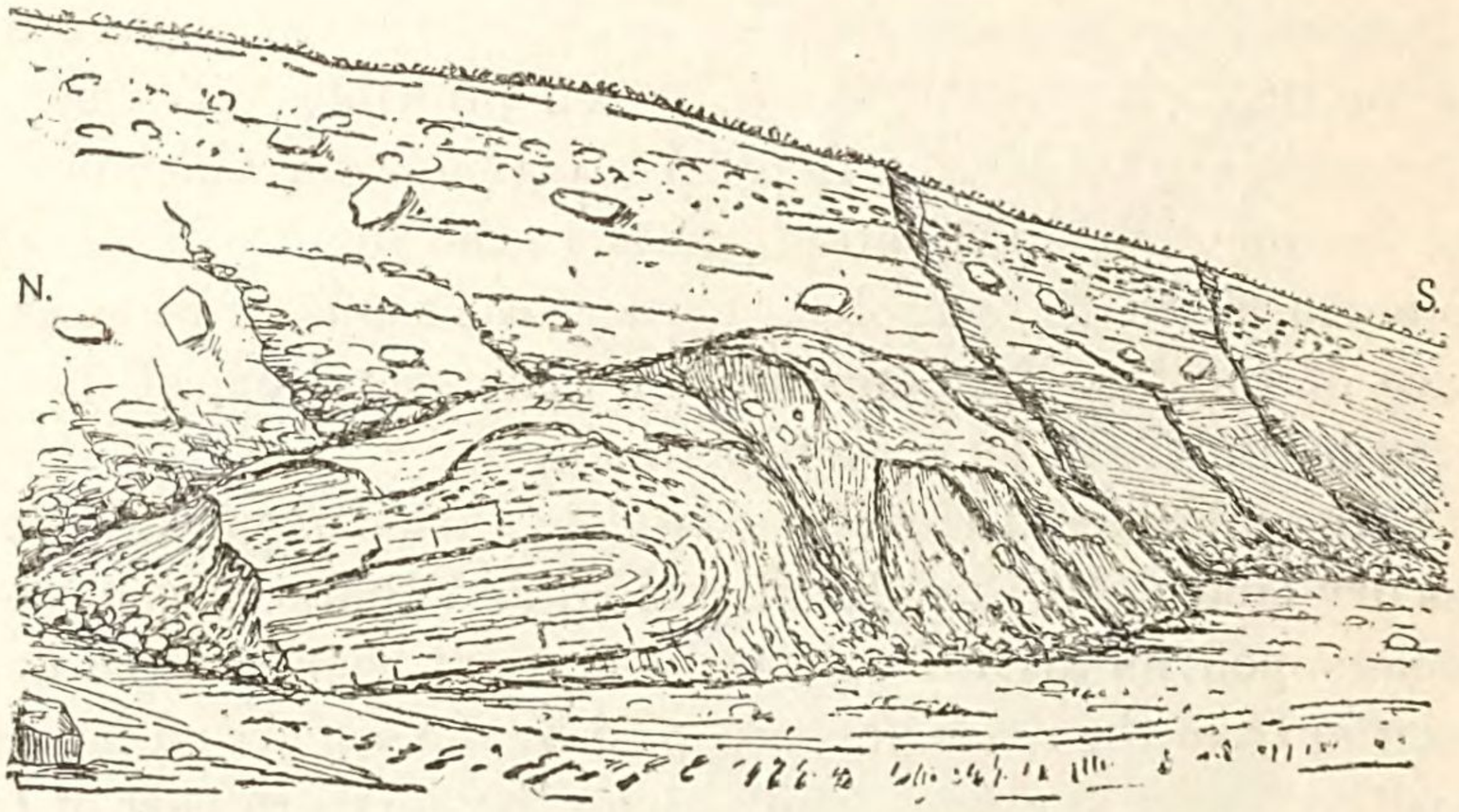
The clays of Staten Island are chiefly Cretaceous, as proven by the fossils found in them. (A. Hollick, Trans. N. Y. Acad. Sci., vol. XI.) The chief outcrops are at Kreischerville, Green Ridge and Arrochar. Besides the clay there are several "kaolin" deposits.

In many instances the clays and overlying yellow gravels have been much disturbed by the passage of the ice over them, and in some cases the sections show overthrown anticlines, as on the fingerboard road at Clifton.

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* Notes on Geology of North Shore of Long Island, Trans. N. Y. Acad. Sci., XIII.

Mr W. Kreischer informed me that the clay at Kreischerville occurs in isolated masses or pockets in the yellow gravel and sands. If such is the case, and if these beds, as is usually supposed, are a continuation of the New Jersey ones, they must be explained as follows: Either the original beds have been torn




Overthrown anticline of Yellow Gravel, Fingerboard Road, Clifton, S. I.

apart by the ice which bore down on them, or else they have been deeply eroded by the currents which deposited the overlying sands and gravels.

The writer favors this latter view.

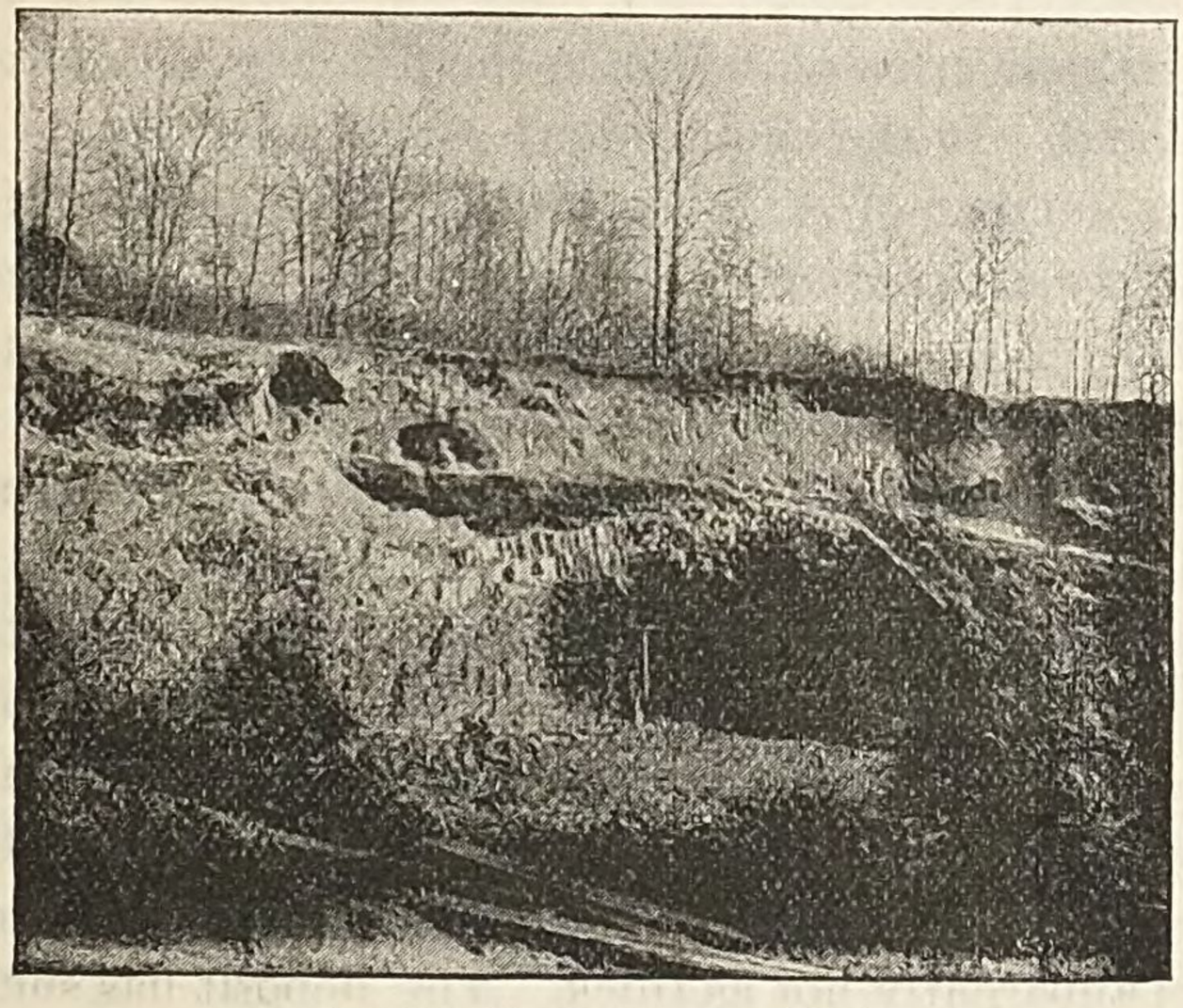
A boring made on the site of Kreischer's fire brick factory showed

| | | |
|---|---|---|
| Sand and soil | 30 | feet. |
| Blue clay | 90 | " |
| White sand | 2 | " |
| Sand and clay alternating | 78 | " |
| Total thickness | 200 | " |

Next to the church at Kreischerville is a bank of stratified sand standing some 40 feet back from the road. It appears to have been dug away considerably, but Mr Kreischer informed me that there was once a large mass of clay at this spot which was surrounded by the sand. To the north of this near the shore is a bank of blue stoneware clay overlain by yellow laminated sand, and southeast of the church is a similar bank, but the clay is of a more sandy nature. A third opening is opposite Kilmeyer's

hotel at Kreischerville, and from this a yellow mottled fire clay is obtained. This latter bed is overlain by about 20 feet of sand and yellow gravel and underlain by a white sand.

A fourth opening on the shore is in a blue clay. It has always been an interesting question as to what extent Staten Island was underlain by the Cretaceous formation, and the following record



CLAY PIT, KREISCHERVILLE, N. Y.
(Yellow gravel over Cretaceous clay.)

of a well bored for Bachman's brewery at Annandale, S. I., seems to throw some light on the subject:

At a depth of 200 feet a bed of yellow gravel containing shells was struck. The gravel was 36 feet in thickness and beneath it was a bed of clay 10 feet thick. This latter was of a white and blue color and was said to resemble a fine pottery clay.

The above may very possibly be some of the Cretaceous clay overlain by the yellow gravel. Borings made at various points along the shore of Arthur's Kill, between Kreischer's factory and Wood & Keenan's brickyard, penetrated a blue clay at a depth of three or four feet. This latter is no doubt of very recent origin.

At the Anderson Brick Company's pit near Green Ridge, the lower clay, which is of a black color, shows signs of disturbance, and slicken sided surfaces are common. The upper portions of

the bank are of blue and gray colors, and at one spot there is a thick seam of lignite. The clay is not sufficiently refractory for fire brick. Fragmentary plant remains were found by the writer in this pit, but they are not nearly so perfect as those found in the fire clay pit at Kreischerville, and which have been figured and described in minute detail by Mr. Arthur Hollick of Columbia College, New York City.

Spicules have been observed in the fire clay at Kreischerville, Staten Island. In the kaolin found near Kreischerville were discovered a number of diatoms, which Dr. Ward informs me are either *Cocconeis placentula*, Ehr., or *Cocconeis pediculus*, Ehr. Their occurrence is also of great interest, as these kaolins are known to be middle Cretaceous beyond doubt.

Stony glacial clays occur also underlying the flats at Green Ridge, Staten Island.

One mile and a quarter northeast of Kreischer's fire brick factory an excavation has been made for obtaining a micaceous kaolin. About 15 feet of it are exposed. A quarter mile north of this locality is the pit of the Staten Island Kaolin Co. The kaolin is evidently a continuation of that exposed in Kreischer's pit, but is apparently not as thick. The deposit has suffered disturbance by the ice sheet and the layers are intermixed with the till. At the northeast side of the excavation a bluish sandy clay containing fragments of lignite is found to underlie the kaolin.

As the Cretaceous clays, kaolins and yellow gravels area continuation of the belt extending across New Jersey, the history of their deposition is the same.*

The following analysis of kaolin from Campbell's pit on Staten Island, is given in the New Jersey clay report cited above:

| | |
|---|---|
| Silicic acid and sand | 93.70 |
| $Al_2 O_3$ and $F_2 O_3$ | 5.70 |
| $H_2 O$ | .70 |
| $K_2 O$ | .35 |
| | 99.45 |

*Report on clays, N. J. Geol. Surv. 1878.

## General remarks on clay

Clay is a hydrated silicate of alumina, having the formula $Al_2 O_3$, $2SiO_2 + 2H_2O$, or silica 46.3 per cent., alumina 39.8 per cent., water 13.9 per cent. This is the mineral kaolinite, and it generally results from the decomposition of granite or other feldspathic rocks. The three essential component minerals of granite are quartz, feldspar and mica, and of the feldspars, orthoclase or the potash feldspar is most commonly present. The surface waters in percolating through the rocks attack the feldspar and leach out the potash as carbonate, or possibly as a silicate if the amount of carbonic acid is small. This breaking up of the feldspar destroys the bond for the quartz and mica and the rock begins to crumble. As a further result of the leaching some silica is set free and left in a hydrated condition. The alumina of the feldspar, the hydrated silica, and some water unite forming kaolinite, the basis of all clays. A deposit of this kind formed in place is a residual clay and its purity is largely influenced by the composition of the parent rock and mechanical conditions, both of which vary. Usually many accessory minerals are present, and destroy the purity of the clay or kaolin. In the general erosion of the land the kaolin together with other minerals composing the rocks are washed into the lakes or ocean, the coarser material transported by the streams being dropped at their mouths to form deltas, while the fine aluminous mud settles in the quieter waters forming a bed of clay. Such deposits of clay are called "sedimentary" to distinguish them from the "residual" ones.

Beds of clay of vast extent are thus deposited in the ocean. With further deposition they become buried far beneath the ocean floor, where subjected to the action of dynamic agencies such as heat and pressure these beds of clay become converted to shale. With subsequent elevation of the sea bottom, and erosion of the new land surface the shale becomes exposed as we now find it over a large portion of the state. The disintegrated outcrops of shale have often been used for brickmaking, having been mistaken for deposits of sedimentary clay. Much aluminous rock flour was produced from the erosion of the shales by the North American ice sheet. This was held in suspension by the

glacial streams and finally deposited as beds of clay in the numerous lakes which occupied the valleys during the early Pleistocene period The erosion of the sandstones has added to the grittiness of the clays. The extensive deposits of plastic clay found on Long Island were elevated above sea level within probably a comparatively short time after their deposition.

Pure clay is of a white color and is very rare. The purest clays known are the China clays, which have about the theoretical composition of kaolinite.

Clays suitable for the manufacture of common brick are by no means uncommon. The impurities in them often run quite high, still in many cases they make a most excellent common brick. The use of a clay for one thing or another is largely determined by the impurities. The clay should be plastic, work easily and burn to a good red color, giving a hard ringing product.

Plasticity is the property which clay has of forming a pasty mass when mixed with water, and changing to a hard mass when subjected to a high heat. Burned clay if ground and mixed with water is not plastic; in fact clay loses its plasticity when the water of combination is driven off. This property of clay is largely due to the kaolinite base which occurs in the form of minute hexagonal tablets.

Dry kaolin is not plastic, and water seems therefore to likewise influence plasticity. Prof. G. H. Cook found that it was also influenced by the degree of fineness of the kaolin. In clays which are very slightly plastic the plates of kaolinite were found to be collected in bunches, and a subsequent thorough grinding in order to break up these aggregates increased the plasticity.

A tough plastic clay is termed by the brickmakers "fat;" on the other hand a clay of loose texture and possessing little plasticity is said to be "lean" or "poor."

Sand consisting of quartz, feldspar or mica destroys the plasticity of clay and is one of the commonest impurities. The others are lithium, titanium, iron, lime, magnesia and the alkalies potash and soda. Sulphur is sometimes present, it having been found in some of the Hudson River clays.

Page* states that "the admixture of a proportion of siliceous sand, which results in a combination containing as much as 90

* Economic Geology, p. 186.

per cent. silica is not incompatible with the formation of a good brick. Uncombined silica, if not in excess, is beneficial, as it preserves the form at high temperatures; in excess it destroys cohesion and makes the brick brittle and weak. Fire clays should not contain over three to four per cent. of fusible impurities.

The fusibility of a clay usually increases with the amount of impurities present. Richter* found that potash rendered a clay more fusible than any of the other impurities; iron is said to come next, then lime and lastly magnesia. Phosphates also increase the fusibility of clay slightly.

Iron is usually present in clay in the form of a lower oxide, and in burning is converted to a higher one, coloring the brick red. According to Seger† the shade of color produced by iron is influenced by the amount of iron oxide present, the chemical composition of the clay, and the mechanical division of the coloring substance, the degree of burning, and whether the fires of the kiln are reducing or oxidizing. The intensity of the coloration increases with the amount of peroxide of iron from four to eight per cent. From this up to 21 per cent. no change in the color was noticed.

Carbonate of lime counteracts the color produced by iron due to the formation of a light colored double silicate of iron and lime. This fact is often made use of in the manufacture of cream-colored brick, a certain proportion of lime being added to the clay. Clays rich in carbonate of lime burn yellow in a reducing atmosphere. If there is an excess of lime the bricks get flesh colored in the oxidizing flame.

If iron is present in the form of sulphate it usually decomposes at the point of fusion, giving a lower oxide which fluxes and produces a distortion of the brick. A reducing flame is detrimental to the formation of sulphate.

It has been stated that a clay containing over three per cent. of lime is not fit for making brick, but this limit is too low, as clays with five and six per cent. of lime will often make a very good product and the celebrated Milwaukee brick have 23 per cent.

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* Brickmaker, Oct. 1892.

† Brickmaker, Oct. 1892.

Magnesia also tends to prevent the development of a red color in bricks.

A white or light-colored brick is sometimes produced if the clay contains a large amount of organic matter which will reduce the iron. Efflorescence is due to the dissolving of the sulphates of magnesia and the alkalies by permeating water, and their deposition on the face of the brick when the water evaporates.

A similar whitish coloring noticed on brick freshly burnt may be due to the reduction of the iron by smoke from the arch fires.

Titanium and lithium are never present in quantity. The latter occurs as titanic acid. Lithium occurs in the clay in a similar form and its presence was first detected in the Cretaceous clays of New Jersey.

Clays weigh 110 to 125 pounds per cubic foot. They have a specific gravity of from 1.75 to 2.00.

Clays may be divided into three kinds:

1 Clay. Mostly alumina and silica in varying proportions, with a small percentage of salts of iron, lime, magnesia, potash, etc.

2 Loams or sandy clays.

3 Marls. Clays containing a large amount of lime.

The refractoriness of a clay is not alone dependent on its composition but is also influenced by its density and fineness of grain.* When two clays are of the same density and fineness, their refractoriness is inversely proportional to the detrimental impurities present, when the latter are equated as to their proper fluxing values. This Professor Wheeler calls the "Fusibility factor" and deduces the formula:

$$\text{F. F.} = \frac{N}{D+D'} \text{ (A.)}$$

N being the sum of the non-detrimentals or total silica, alumina, titanic acid, water, moisture and carbonic acid gas.

D = sum of detrimental impurities as iron, lime, magnesia, alkalies, sulphuric acid and sulphur.

D′ = sum of the alkalies. This latter is added because the alkalies have about twice the fluxing power of the other detrimentals. The effect of FeO is not considered as it is quickly

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* H. A. Wheeler, "Calculation of the Fusibility of Clays." Eng. and Min. Jour., March 10, 1894.

changed to $Fe_2 O_3$ when the clay is heated. This formula gives a good comparative value of the refractoriness of two similar clays whose specific gravity does not differ by more than .2.

When the clays to be compared differ in fineness, the formula (A.) is modified by the constant C.:

$$F.\ F. = \frac{N}{D + D' + C} \text{ (B.)}$$

C = 1 when the clay is coarse grained and sp. gr. over 2.25.
C = 2 when the clay is coarse grained and sp. gr. 2.00–2.25.
C = 3 when the clay is coarse grained and sp. gr. 1.75–2.00.
C = 2 when the clay is fine grained and sp. gr. is over 2.25.
C = 3 when the clay is fine grained and sp. gr. 2.00–2.25.
C = 4 when the clay is fine grained and sp. gr. 1.75–2.25.
The value of C is to be considered only approximate.

The temperature of fusion of a clay is usually determined by means of a pyrometer. Two kinds have been more or less used for this purpose, viz., the Lunette pyrometer and Le Chatelier's thermo-electric pyrometer, which is far more accurate. These pyrometers have also been used to determine the temperature of kilns.

## Method of analyzing clays

By Dr. H. T. Vulte.

One grain of the dried and finely pulverized clay is fused in a platinum crucible with five to 10 times its weight of a mixture of 11 parts of dry sodium carbonate and 14 parts of dry potassium carbonate, the amount of fusion mixture necessary depending on the more or less refractory character of the clay. The fusion is transferred to a porcelain casserole, dissolved in water, and the solution acidified with hydrochloric acid; the solution is then evaporated to dryness, and the casserole with its contents placed in a drying oven at 105° to 110° C., and allowed to remain until all the hydrochloric acid is expelled. The silica present is thus rendered insoluble. Hydrochloric acid and water are now added; the casserole is warmed for a few minutes on the water bath and the solution filtered, the silica being washed with hot water until the washings are free from chlorine. The silica is then ignited and weighed, and as it is likely to retain small quantities of alumina, it is treated with hydrofluoric and sulphuric acids and heated, the silica being thus volatilized as

silicon tetra fluoride. The residue from this treatment is weighed, and its weight added to that of the alumina subsequently found.

If the original fusion of the clay showed little or no green color, the filtrate from the silica is treated with a slight excess of ammonia, and the solution boiled for a short time to expel the excess. The solution is then filtered, the precipitate dissolved in dilute hydrochloric acid, and reprecipitated in the same way; filtered out, washed and then ignited and weighed, giving the amount of alumina and iron (as $Fe_2O_3$) present. The combined filtrates from the iron and alumina, which should be concentrated to about 200cc., are heated to boiling and about 25cc. of sat. sol. of ammonium oxalate added, and the boiling continued for two or three minutes longer, when the heat is removed and sufficient ammonia added to render the solution strongly alkaline. The precipitate is allowed to settle, and the supernatant liquid decanted off as closely as possible through a filter; hydrochloric acid is then added to the precipitate to dissolve it, and then sufficient ammonia to reprecipitate it. It is then washed on to the filter; washed; ignited with sulphuric acid, and weighed as calcium sulphate. The filtrate receives a further addition of ammonia and of hydrodisodic phosphate, is well stirred, allowed to stand for some hours in the cold, when the magnesium precipitate is filtered out, washed with ammonia, ignited and weighed.

In case manganese is present, the filtrate from the silica is neutralized as closely as possible, sodium acetate solution added, the solution diluted largely, and boiled for about a minute and filtered as rapidly as possible, the precipitate washed with boiling water, redissolved in dilute hydrochloric acid and reprecipitated in the same way, washed, ignited and weighed as $Fe_2O_3$ and $Al_2O_3$. The combined filtrates from the iron and alumina are evaporated to about 300cc., bromine water added and the solution boiled when the manganese is precipitated as $MnO_2$. This is filtered out, dissolved in a little dilute hydrochloric acid, a solution of microcosmic salt added, the solution heated to boiling and then ammonia added to exact neutrality, any excess of ammonia being removed by heating on the water bath. The precipitate of manganese ammonium phosphate is filtered out, ignited and weighed as $Mn_2P_2O_7$. The filtrate from the manganese precipitation is acidified with hydrochloric acid, boiled

for a short time, and then treated in the same way as when manganese was absent, for the determination of lime and magnesia.

For the determination of alkalies one grain of clay is mixed by grinding in an agate mortar with one grain of granular ammonium chloride and eight grains of pure calcium carbonate, the mixture transferred to a platinum crucible with a well-fitting lid and slowly heated to decompose the ammonium chloride, then heated to redness and the bottom of the crucible kept at a bright red for about an hour. The contents of the crucible are transferred to a porcelain casserole with about 80cc. of water and heated to boiling; this is then filtered and to the filtrate after evaporation to small bulk about one and one half grams pure ammonium carbonate added and the solution heated nearly to boiling and filtered into a platinum dish, evaporated nearly to dryness, a little more ammonium carbonate added and the evaporation finished on the water bath. If the last addition of ammonium carbonate produced a precipitate the residue in the dish is dissolved in a little water and filtered into another platinum dish where it is evaporated into dryness and ammonia salts driven out by heat. The residue is dissolved in water filtered into a weighed platinum dish, evaporated, dried and weighed as Na Cl + K Cl. If the last addition of ammonium carbonate failed to produce a precipitate the transfer to another dish may be dispensed with and the ammonia salts driven off at once.

## Prospecting and exploiting

In prospecting for clay the topography is often of much help. In the northern and western portions of the state the clay is generally found in the bottoms of broad valleys. An example of this is the Genesee Valley. Again at other localities the clay is found underlying terraces along the sides of the valleys as in the Hudson valley and along Lake Champlain. Deposits of a similar character will be found along the Delaware and Susquehanna Rivers. A terrace however does not necessarily indicate the presence of clay, for some of the Hudson valley terraces are underlain by till.

On Long Island for example the clay is found almost entirely along the north shore; it no doubt underlies most of the island, but on the southern side there is in most instances such a covering of sand as to make it useless. The presence of clay can often be detected in railroad cuttings, in the sides of gullies or ravines. In many instances however the occurrence of clay is only suspected, and then borings must be made with an auger to determine its presence. As a deposit of clay is seldom of uni form thickness throughout its extent, a sufficient number of borings should be made in order to fully determine this point; a bed of clay may be 40 feet deep at one point and thin out to five or six feet within a distance of 15. The writer has seen several instances in which expensive plants have been erected and come to a speedy end simply because the clay gave out, whereas the disaster might have been avoided by previous exploitation. Another important point to determine is the presence of sand for molding and tempering. Many of the clays in this state can not be made into brick without the addition of sand. Along the Hudson River and on Long Island tempering sand is a much needed article, but fortunately it is near at hand. With molding sand it is different, for wherever soft mud machines are used it is necessary. Very often it can be obtained from some neighboring hill, but sometimes it has to be brought long distances.

The presence of a large deposit of clay is not the only fact necessary to be determined. The question next arises, is the material available for the purpose for which it is to be used, and what sort of machinery will be the best suited to work it. By far the best way is to take several barrels of clay and have it made into the desired product by different methods. There are brickyards where this can be done, or even the manufacturers of different machines offer to do this at their works. Crushing a lump of clay between the fingers or tasting it will give some idea of grittiness, but it is impossible to tell by this method the quality of the clay or its availability for one purpose or another.

Having determined by boring or otherwise the extent and thickness of the clay at the locality where the brickyard is to

be established, the next step is to strip a portion of the surface to a sufficient depth to expose the clay.

The amount of stripping to be done varies. On Long Island it is sometimes as much as 20 or 30 feet. Along the Hudson valley it varies from a foot or two of loam, or three or four feet of sand up to 15 or 20 feet. In both these regions the sand can be used for tempering, though the quantity stripped is far in excess of the demand. At some points in the Hudson valley the surface is covered with scrubby trees which are troublesome to remove. In the northern and western portions of the state, there is at most places only a foot or two of soil covering the clay.

When a yard is first started, the stripping, whatever its character, can be used for filling.

Natural drainage is always an extremely desirable thing, for having to keep the clay pit clear of water only adds to the cost of production. Neighboring streams and springs are often a constant source of annoyance, especially if the clay deposit is situated in a valley. They are chiefly troublesome when the sand bed, which often underlies the clay, is struck and allows the water to run in and flood the workings.

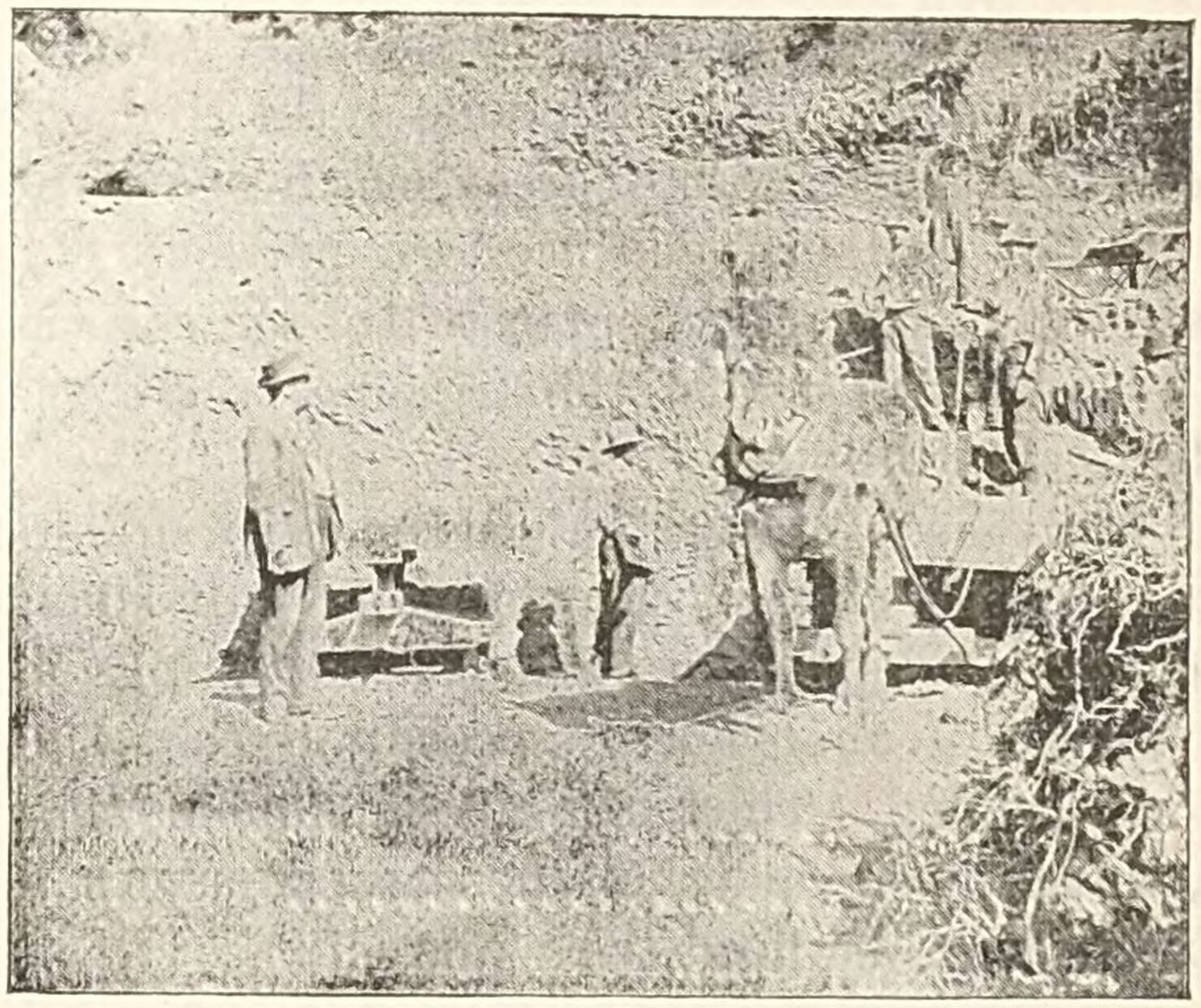
## Working clay

Having uncovered the clay several methods are employed to work it.

1. The clay is dug at any convenient spot in the bank, usually at the base, working inward; thus in the case of a high bank eventually leaving quite a steep face. The bank is apt to slide sooner or later and the men begin again at the base of the slip and work inward. There is one disadvantage in this method and that is that the several qualities of clay, if it be in strata, become mixed, which is not desirable in all cases. It has, however, the advantage in the case of a bank of clay of making the haulage all on one level. Of course, in this method, haulage by cart is the most convenient. Costs 25–30c. per 1000 brick for about 500 feet of lead.

2. A second method, but one rarely used, is to loosen the clay by means of plows and bring it to the yard by scraper, provided of course the clay bank adjoins the yard. Very few yards employ this method. It costs about 20c. per 1000 brick to plow the clay and

bring it down with scrapers. To this must be added the price of getting the clay from the heaps to the molding machines, a distance of about 50 feet. In plowing clay the bank is usually worked at an angle of about 30 degrees. This method has no especial advantage. The clay is broken up more and exposed to the



Loading clay on cars.

weather for several days, but as far as I am aware this does not add materially to the quality of the brick when the molding is done in soft mud machines, which are used at all the yards digging their clay by plows.

3. *Working in benches.*— This method is the one most commonly used where the bank is over 25 feet high. The benches are six to eight feet wide and seven to nine feet high. Roads lead up to the separate benches, and each bench is worked in advance of the lower one.

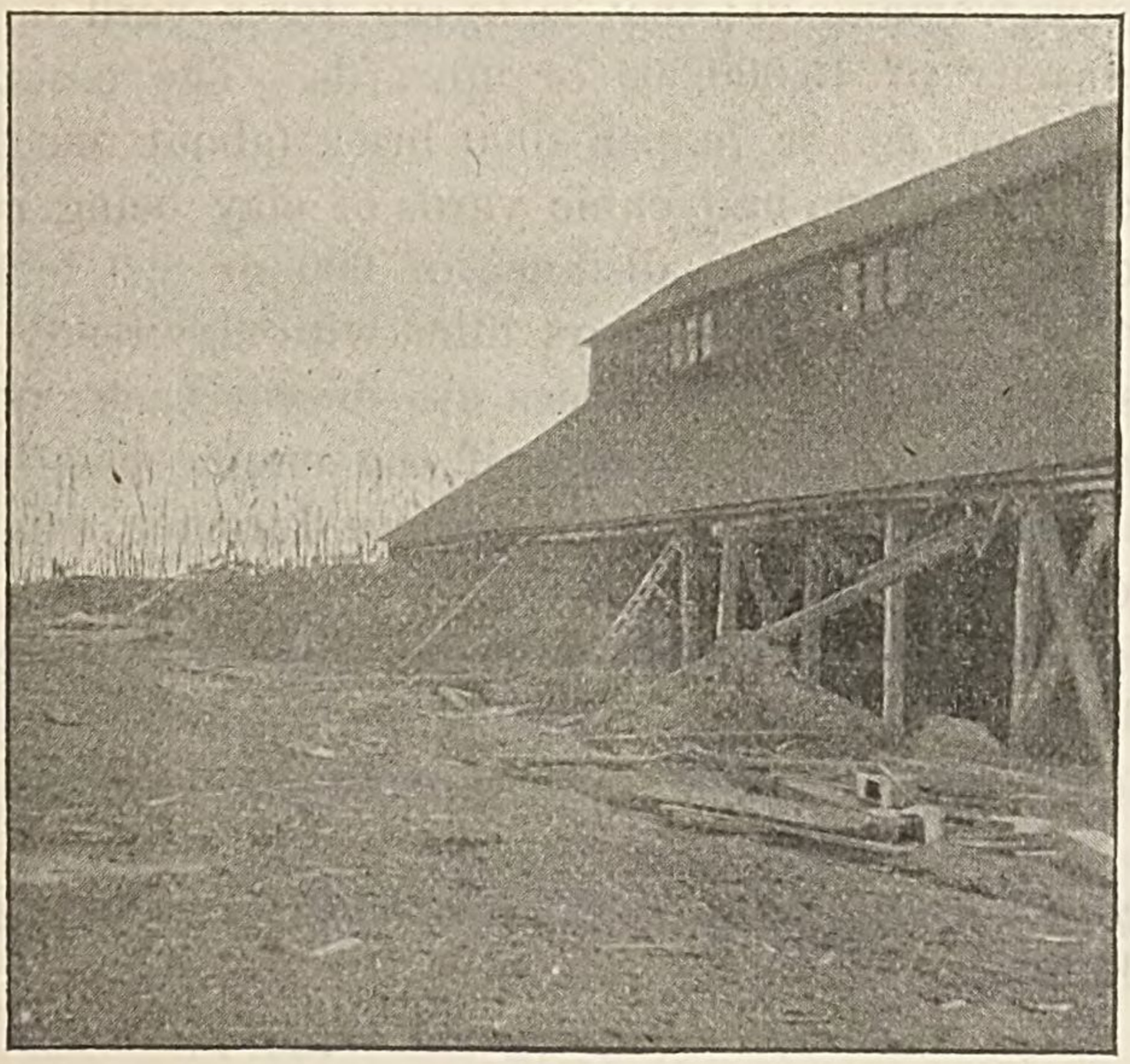
Where the clay has streaks of quicksand the roads have to be planked. If the bank is below tide level there is the additional expense of pumping. This method is of importance along the Hudson River where many of the clay banks are of considerable height, and the use of benches often prevents a slide of the clay.

4. *Steam shovel.*— Although this method of mining has been successfully practised at many western localities the only place in this state where it has been tried is Croton Landing in the Hudson valley. These clays do not as a rule stand well with a

vertical face, and as a result the bank slid, burying the shovel. Where the clay bank contains several different layers of clay, which are mixed together for making brick, the steam shovel is a good thing, as it digs from bottom to top of the bank each time.

5. *Dredging.*— This method like the preceding is only practised at one locality, viz., Croton Point. The dredged clay is dropped into hoppers, which, when full, are run up inclined planes on shore and dumped. Costs 12–15c. per 1000 delivered on shore; then 12c. for haulage to ring pits.

6. *Undermining.*— Many brick manufacturers use this method of mining their clay, especially when the latter is tough. Wedges are driven in on the upper surface a foot or two from the edge; at the same time the face is undermined by picking to a distance of two or three feet. It is not advisable to work a



Shale bank covered by a shed.

bank over 20 feet high by this means, and in almost any case it is a rather dangerous method to employ.

7. *Blasting* is very often resorted to in banks of tough clay and always in the case of a shale bank. A small charge of dynamite usually suffices to bring down a large quantity of the material.

*Haulage.*— The brick manufacturer generally locates his plant near the supply of clay, so that the haulage distance is from 100 to 300 feet. Within these limits it is economical to use one-horse carts, but above 300 or 400 feet there are other means of haulage which will generally be found cheaper. There are exceptions where carts are used for hauling long distances; for instance, at Port Ewen on the Hudson the clay is carted 900 feet in some cases, and at Haverstraw some of the firms bring their clay a distance of a quarter of a mile in one-horse carts.

*Cars.*— As a rule where the haulage distance exceeds 500 feet cars are used. They are run on tracks and drawn by horses; if possible the track is laid down grade from the bank to the yard. Sometimes the loaded cars are run down to the yard by gravity, the horses being only required to draw them back when empty. Cost 10c. per cubic yard for about 500 feet lead.

*Locomotive haulage.*— This is a cheap method where the scale of operations warrants it; that is to say, for a yard having an annual capacity of 15,000,000 or upwards. The cost by this method is about 5c. or 7c. per 1000 brick (about one and one quarter to one and one half cubic yards of clay being reckoned to a thousand brick) for a distance of 600 or 800 feet. It is necessary, of course, to have cars filled with clay ready for the engine as soon as the empty ones are drawn back; otherwise the expense would become great if the engine had to spend much time waiting. The cost given above does not include wear and tear on plant.

*Wire rope haulage.*— A few yards use this method where the haulage distance is small; the winding drum is placed under the machine shed near the pug mill or crushers; side or bottom dumping cars are used.

*Gravity planes* may also be mentioned, but they are less used than they might be.

## General remarks on bricks

Three kinds of brick are manufactured in New York, viz.: Common, front and paving brick.

Common brick. These constitute nine tenths of the clay products manufactured in the state. The following are the characteristics of a good building brick.

1. It should have plane surfaces, parallel sides, and sharp edges and angles. The regularity of form depends largely on

the clay from which the brick is made and the method of drying and burning.

2. It should be of fine compact and uniform texture, quite hard and give a clear ringing sound. The compactness and uniformity of texture, which greatly influence the durability, depends mainly on the method of moulding. Hand machines produce brick of homogeneous character. Tempered clay bricks are denser interiorly. Dry clay machines produce a thoroughly homogeneous and dense brick it is claimed.

3. It should not absorb over 10 or 15 per cent. of water. A simple method of testing this is to place the brick for 24 hours in a bucket of water, weighing it before and after immersion. The increase of weight is the amount of water absorbed. This applies only to hard burned bricks. A salmon or green brick will absorb much more.

4. It should have a specific gravity of 20 or more.

5. It should have a crushing strength of not less than 3000 pounds per square inch.

The manner of making crushing tests is described under the head of paving brick.

Building brick may be divided into three kinds, arch, red and salmon.

Common bricks run quite uniform in size. There is a difference of perhaps three sixteenths inch between a brick made in a new mold, and one made in a mold which has been used one or two seasons. The dimensions of an average sized common brick are about two and one quarter by three and three quarters by eight and one quarter inches. We give below a table of the sizes of common brick manufactured in this state together with the amount of water they absorbed when soaked for 24 hours.

| | Size of brick. | Weight Before Soaking | | Weight After Soaking. | | Percentage of water absorbed. | |
|---|---|---|---|---|---|---|---|
| | | Lbs. | Ozs. | Lbs. | Ozs. | | |
| East Williston | ..... | 4 | $1\frac{1}{2}$ | 4 | 6 | 6.7 | Soft mud. |
| Southold | $2\frac{1}{8} \times 3\frac{3}{8} \times 7\frac{1}{2}$ | 3 | $12\frac{1}{2}$ | 4 | 3 | 10.7 | Soft mud. |
| Farmingdale | $2\frac{3}{16} \times 3\frac{1}{2} \times 7\frac{5}{8}$ | 3 | $11\frac{1}{2}$ | 3 | $15\frac{1}{2}$ | 7.0 | Soft mud. |
| Croton, W. A. U. | $2\frac{5}{16} \times 3\frac{5}{8} \times 8\frac{3}{16}$ | 4 | 6 | 5 | $\frac{1}{2}$ | 15.4 | Soft mud. |
| Haverstraw | $2\frac{3}{16} \times 3\frac{7}{16} \times 7\frac{7}{8}$ | 3 | 11 | .... | .... | ..... | Soft mud. |
| Syracuse | $2\frac{2}{8} \times 3\frac{13}{16} \times 7\frac{6}{8}$ | .... | .... | .... | .... | ..... | Soft mud. |
| Warners | $2\frac{3}{16} \times 3\frac{7}{8} \times 8\frac{3}{16}$ | 5 | 11 | 5 | 17 | 6.3 | Stiff mud. |
| Canandaigua | $2\frac{3}{8} \times 4 \times 8$ | 5 | $\frac{1}{2}$ | 6 | $4\frac{1}{2}$ | 24.8 | Dry clay. |
| Rome | $2\frac{3}{16} \times 3\frac{3}{8} \times 7\frac{6}{8}$ | 3 | 8 | 4 | $1\frac{1}{2}$ | 17.9 | Common. |
| Rome | $2 \times 3\frac{15}{16} \times 7\frac{13}{16}$ | 4 | 3 | 4 | 5 | 2.9 | Stiff mud. |
| Owasco | $2\frac{1}{2} \times 4\frac{1}{4} \times 8\frac{3}{4}$ | 5 | $\frac{1}{2}$ | 5 | 14 | 16.7 | Repressed. |
| Saratoga | $2\frac{3}{16} \times 3\frac{3}{4} \times 2\frac{3}{16}$ | 4 | $2\frac{1}{2}$ | 4 | $8\frac{1}{2}$ | 9.0 | Soft mud. |
| Buffalo | $2\frac{1}{4} \times 3\frac{1}{4} \times 8\frac{1}{8}$ | 4 | $13\frac{1}{2}$ | .... | ... | ..... | Soft mud. |
| Dunkirk | $2\frac{3}{16} \times 3\frac{11}{16} \times 7\frac{3}{16}$ | 4 | $3\frac{1}{2}$ | 4 | 14 | 15.5 | Soft mud. |
| Jamestown | $2\frac{1}{2} \times 4 \times 8\frac{1}{4}$ | 4 | 11 | 5 | $5\frac{1}{2}$ | 14.0 | Soft mud. |
| Hornellsville | $2\frac{3}{8} \times 4\frac{1}{8} \times 8\frac{3}{8}$ | 7 | 2 | 7 | 4 | 1.7 | Stiff mud. |
| Newfield (yellow) | $2\frac{3}{16} \times 3\frac{7}{8} \times 7\frac{13}{16}$ | 5 | $5\frac{1}{2}$ | 5 | 7 | 2.9 | Stiff mud. |
| Newfield (cream) | $2\frac{3}{16} \times 4\frac{1}{10} \times 8\frac{1}{4}$ | 5 | 8 | 6 | $5\frac{1}{2}$ | 15.3 | Stiff mud. |
| Jewettville | $2\frac{3}{8} \times 4 \times 8\frac{1}{4}$ | 5 | $11\frac{1}{2}$ | 6 | 1 | 5.4 | Dry clay. |

*Permeability.*—On account of the peculiar construction of the Croton aqueduct there are several points at which a considerable pressure is exerted on the bricks and a consequent permeation of the water through them. A number of tests have been made by A. W. Hale, engineer on the aqueduct, and a full description of the apparatus and method used is given in pp. 17 and 28, Eng. Record, 1890. The bricks tested were the Anchor brand of Croton Landing, N.Y. It was found that with 80 pounds pressure per square inch, the average percolation through a brick two and three eighths inches thick, was equal to 12 and 3-12 cubic inches per square inch of surface, per hour. The maximum percolation was 40.44, and minimum was 4.02 cubic inches. From these experiments Mr. Hale drew the following conclusions.

That the percolation through a brick under constant pressure, diminishes as the pressure is prolonged.

That the diminution of percolation under constant pressure is less and less rapid as the flow is continued and finally becomes constant.

## Paving brick

The paving brick industry, although in its infancy, gives indication of rapid growth in the near future. In the western states many cities are paving their streets with brick. In this state brick pavements have been introduced in the following cities, Binghamton, Lockport, Buffalo, Rochester, Syracuse, Troy, Watertown, Ithaca, Corning, Elmira, Dunkirk, Jamestown, Tonawanda and Niagara Falls. There are only four factories in New York state which furnish paving brick, and up to the present time many of the pavers used in the state have been obtained from West Virginia and Ohio. It was formerly thought that only fire clays should be used in the manufacture of this product, but this idea is being abandoned, for there are many clays which are refractory enough for a fire brick which makes most excellent pavers.

In order to make a good paving brick the clay should be one which will hold its shape at a heat sufficiently high to cause thorough "vitrification", (as brickmakers call it.) It should shrink evenly in burning. It should be tough but not brittle, and withstand abrasion. It should also withstand considerable pressure;

10,000 to 12,000 pounds per square inch are probably sufficient. It should be homogeneous throughout. It should be dense and not absorb over two or at the most three per cent. of water.

In the manufacture of paving brick, the clay must be thoroughly drepared before being molded. Some clays can be ground, screened and pugged as soon as taken from the bank, while others have to be weathered or soaked before crushing. The machine used for molding depends on the clay. Some clays make a first-class paving brick by the dry press process, while others give the best quality with a soft mud machine. In any case the green brick should be as dense as possible. After molding, the bricks are dried in tunnels. The drying should not be hurried. Burning is usually done in down draft kilns. The kiln should not be too high in order to avoid the bricks in the lower part of it being crushed out of shape by the weight of those above, at the time the fires are hottest. In burning, the fires are raised till temperature of vitrification is reached, and they are held at this temperature for from 24 to 48 hours. Cooling is done very slowly, thus annealing the brick. The term "vitrification" is a misnomer. To vitrify a brick would be to convert it into a glass in which state it would be brittle and useless. What takes place is that the bricks are raised to a temperature sufficient to flux the potash, lime and iron with the silica and give a dense brick, and it is in order to thoroughly accomplish this, that the brick is kept for 24 or more hours at the point of fluxing or "vitrification."

## Testing paving brick

1. Absorption. To determine the amount of water which a paver will absorb, it is soaked in water for 20 hours and weighed before and after. The increase in weight is the amount of water absorbed.

2. Abrasion. The bricks are weighed and then put in a rattler together with foundry shot and the rattler revolved for several hours at 52 revolutions per minute. The bricks are again weighed, the loss being due to abrasion.

Another method of making this test is to grind the brick on a horizontal stone, 14 feet in diameter and making 28 revolutions a minute. This is kept up for eight hours, the brick of course being weighed before and after.

3. Crushing tests. The brick to be tested is put on edge between the two plates of a crushing machine. The amount of pressure is noted at which the brick cracks, and also that at which it crushes. Before testing, the two sides of the brick on which the pressure is exerted should be ground perfectly smooth and be made exactly parallel. To further insure an even surface some material, such as paper or cardboard or plaster of paris, is put between the surface of the brick and plate of the machine. The following experiments made by Prof. I. O. Baker* show that for the same brick the results obtained vary with the method of preparing the surface. The bricks tested by him were prepared in the following manner:

1. Grinding as nearly flat as possible on convex side of emery stone and crushing between self-adjusting, parallel cast iron plates.

2. Removing the irregularities of surface and crushing between blotting paper.

3. Removing the irregularities of surface and crushing between straw boards.

4. Removing irregularities, coating with plaster of paris and placing under slight pressure until set (12–24 hrs.), and then crushing.

5. Coating with plaster of paris which was afterward ground down on a sand paper disk, to the surface of the brick so as to leave a minimum thickness with a perfectly flat surface and then crushing.

After a number of experiments no great difference was found between the first three, but difficulties connected with the last two rendered them worthless. With a uniform grade of brick the first three methods gave 7000 to 9000 pounds as crushing strength of cubes. Some samples of the same lot of brick were prepared on rubbing bed at marble works, and the strength of these carefully prepared cubes ranged from 16,000 to 21,000 pounds per square inch, showing that a very small difference in flatness of surface makes a great difference in the apparent strength.

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* Clayworker, June, 1892.

Trautwine states that cracking and splitting usually commences under about one half the crushing load.

## Front brick

Up to a few years ago in order to obtain a smooth, sharp-edged brick such as could be used for the outside of walls, the roofing of archways and other conspicuous places, the brick was first molded in an ordinary soft mud machine, or what was considered better, molded by hand. This green brick was then allowed to dry for a few hours and then put in a repressing machine. At the present day a smooth and sharp-edged "front" brick can be molded and made of sufficiently good appearance in one operation. The modern dry clay brick machine will do this. Repressing machines, however, are still extensively used. They are operated by hand power and one brick is treated at a time. Repressing machines run by steam power have recently been introduced and will undoubtedly be found to be more economical for those who have much use for this class of machines and work quicker than the hand power ones. As far as the writer is aware only one firm in this state, the Corning Brick Co., is at present using steam power repressing machines. Hand represses are in use at several localities. At the yard of T. B. Campbell at Newfield, near Ithaca, the bricks are first made on a wire cut machine and then repressed. W. W. Parry of Rome, N. Y., uses a similar method. The Hornellsville Brick Co. repress their paving brick. Some firms make a front brick on a soft mud machine and do not repress them. These latter machines do not, however, always exert sufficient pressure to produce a dense brick such as is required for fronts of buildings.

As stated above, a repressed brick should have smooth faces, sharp edges and square corners. For this class of product a clay is needed which will burn to a hard brick, having a good color and one which will also retain its shape and size fairly well in burning. The clay should be thoroughly pugged before molding, and very often better results are obtained by mixing two or more clays. Pressed brick usually take a longer time to burn and on account of their greater density have to be dried very slowly and carefully.

## Method of manufacture

Bricks are usually made by one of the following three processes :

Soft mud
Stiff mud or wire cut
Dry clay

The processes are not wholly distinct from each other, for there are machines that may be used as well in connection with one as the other. For instance, in preparing the clay for molding in a stiff mud machine, we may use either a pug mill or a pan crusher, though the latter belongs preferably to the dry clay process. Whatever be the method, the manufacture of clay into brick involves the following steps, preparation, molding, drying, burning, and below is a classified arrangement of the stages in the process of brickmaking and machines used.

*Methods*

- 1. Digging by pick or shovel at any portion of bank
- Mining the clay:
  - 2. Bench working
  - 3. Undermining
  - 4. Steam shovel
  - 5. Plows and scrapers
- 6. Dredging

*Machines used*

- Haulage:
  - Carts
  - Cars on tracks, drawn by horses
  - Steam
  - Wire rope planes:
    - Self-acting
    - Steam power
- Preparing or tempering:
  - Barrel sieves
  - Roll crushers
  - Soak pits
  - Ring "
  - Pug mills
  - Pan crushers:
    - Wet pans
    - Dry pans

- Molding
  - Soft mud machines
    - Hand power
    - Horse "
    - Steam "
  - Stiff " "
    - Auger
    - Plunger
  - Dry clay
- Drying
  - Open yards, sundried
  - Covered yards, air dried
  - Pallets
  - Tunnels heated by
    - Steam pipes circulating within
    - Hot blast
    - Hot air from coal fire through flues underneath
- Burning kilns
  - Down draft
    - Rectangular
    - Circular
      - One or more chimneys according to make
  - Up draft
    - Scovekilns
    - Clamps

## Soft mud process

*Preparation of the clay.*—This step in the manufacture of clay products is of great importance, and on it success or failure often depend. No fixed rule can be laid down for the preparation of all clays. Two clays may have a similar chemical composition and yet their physical condition may be such as to necessitate entirely different modes of treatment. A particular clay may give the finest quality brick by the soft mud process, while if molded in a dry clay machine it will produce a brick that is absolutely worthless. There are clays on the other hand which make a good brick by several methods. In any case, however, whatever the method or the clay, it should be prepared, and the more thoroughly this is done the better. Many advocate weathering the clay. This will break up the clay and thereby lessen somewhat the expense of mixing but does not add to the quality of the finished product.

In the soft mud process the clay is usually prepared either in soak pits, ring pits or pug mills.

Hematite is often added to the brick to give it a nice red color. It is either added to the clay while it is being tempered in the pug mill or else the powdered hematite is mixed with the molding sand. The former way is undoubtedly the best, for in the handling and rubbing which a brick gets before it is finally placed in a wall, much of the molding sand is rubbed off and with it the hematite.

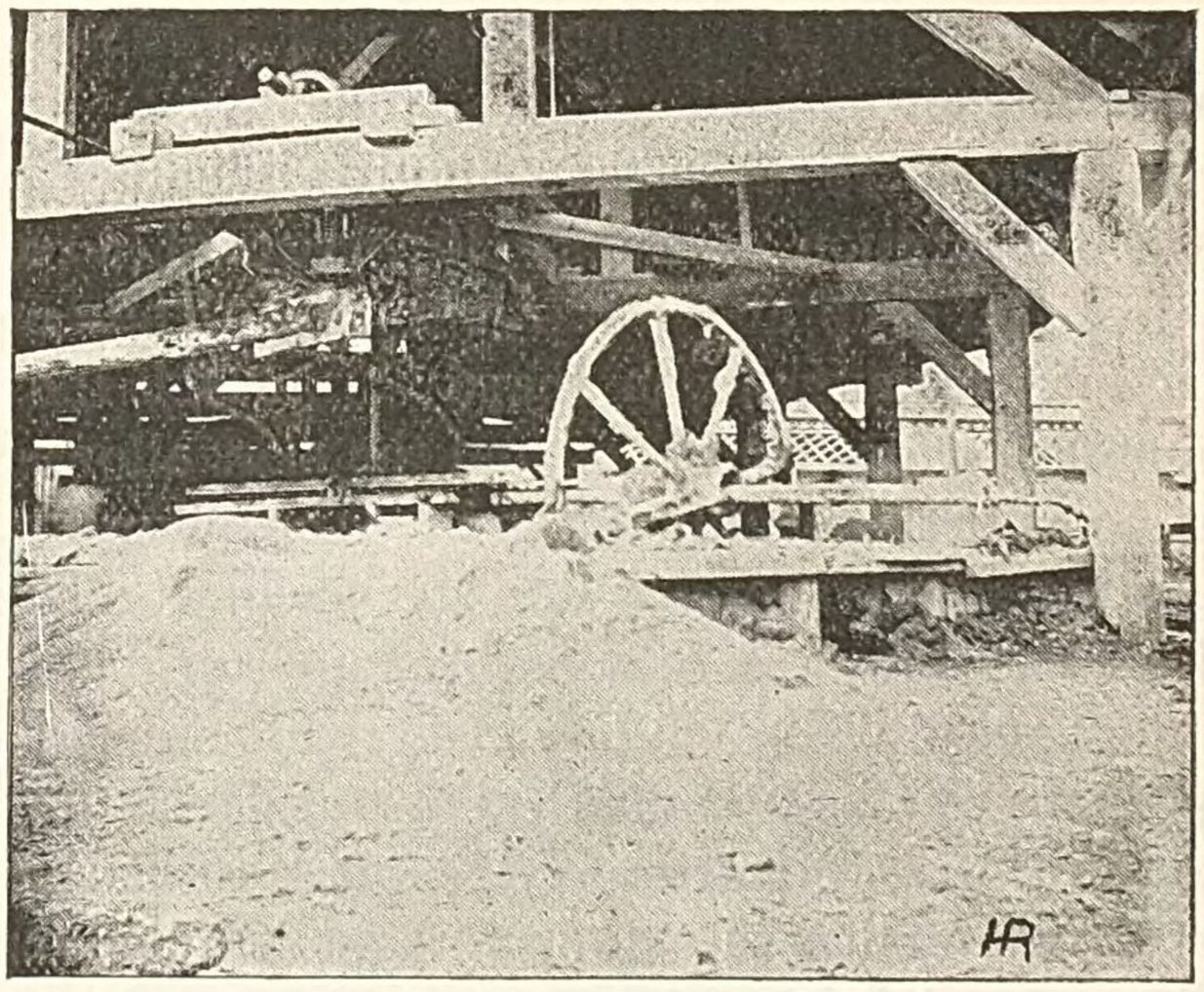
*Soak pits.*—These are the most primitive machines at present used for the preparation of clays. It consists of a rectangular pit about five feet deep and six feet square. The Long Island ones are usually rectangular in shape. Into this the clay and sand are dumped, water poured on and the mass allowed to soak over night, so as to thoroughly soften it. The following morning the softened material is shoveled into the machine. Two men — pit shovelers — do this, and it is highly important that they be men of intelligence and attend to their work, seeing that the right proportions of clay and sand are shoveled into the machine. From one third to one quarter is the amount of sand added. The operation of mixing the clay and sand is called tempering; the addition of sand is in most cases not necessary, as the majority of clays have sufficient of it admixed naturally. The object of the addition of sand is to counteract the effect of the alumina, by preventing a too great and uneven shrinkage of the brick. Coal dust is also added by some manufacturers and the advantage derived by its use will be mentioned under the head of burning.

When soak pits are used, two men dig the clay in the afternoon at the bank, while a third man levels off the material as it is dumped into the pit and also adds the requisite amount of water. He is called the temperer. In the morning the two diggers of the previous afternoon shovel the clay from the soak pit into the machine.

In many large brickyards separate gangs of men do the pit shoveling and digging of the clay.

*Ringpits.*—These temper the clay more thoroughly than soak pits, but are not so extensively used, possibly because it costs a trifle more to operate them. A ringpit, as its name implies, is circular, 25 to 30 feet in diameter, three feet deep and lined with boards or brick. In this there revolves an iron wheel, six feet in

diameter and so geared that it travels from the center to the circumference of the pit and then toward the center again. In this manner the clay is thoroughly broken up and mixed with the sand and coal dust, if this latter be added. The pitfull is



Ring pit for tempering clay

tempered in about six hours, and a pit holds sufficient for about 30,000 brick. The tempering is usually done in the afternoon so as to have it ready for the next morning. When the tempering is finished, a board is attached by ropes to the wheel and dragged round the pit a few times to smooth the surface of the clay; a thin crust forms on the surface and prevents the moisture in the underlying material from evaporating.

With ring pits there is a similar arrangement as with soak pits, the only difference being that the temperer previously mentioned is generally employed in the morning to wheel the clay from the ring pit to the molding machine.

As a rule there are two ring pits to a machine, so that while the clay is being shoveled from one pit to the machine, the other pit is tempering clay for the next day, or two pits and two machines are used, but each pit in this case holds enough material for the daily use of two machines.

*Pug mill.*—This machine, like the ring pit just described, is used for thoroughly mixing the clay, or clay and sand as the case may be, before introducing it into the machine. It consists

essentially of a semi-cylindrical trough, six to 10 feet long, in which there revolves a shaft, bearing knives set spirally around it, or a worm screw six or more inches wide. The material is put in at one end, and the knives or thread mix it up. At the same time it is worked along to the other end of the trough from which it is discharged into the machine. The pug mill may be closed or open; the former is better as there is a more uniform pressure on the clay while it is being tempered, and a more thorough mixing results. Water is also added from a faucet at the upper end of the trough until the clay is in the right condition. The angle of the knives with relation to the shaft can be changed so that the clay can be moved along slower or faster as it is desired. The trough of the pug mill is of iron or wood, usually the former. A pug mill, according to its size, will in 10 hours temper clay enough for from 25,000 to 60,000 brick. Pug mills take up less room than ring pits and do not require as much power to operate them. They will also, if desired, discharge the clay directly into the molding machine. They are used chiefly with stiff mud machines.

*Molding.*—Having prepared the clay by one means or another, according to its character, and somewhat according to the machine to be used, the next step is to mold it into bricks. The old-fashioned method of molding bricks by hand is rapidly dying out, yet every now and then we come across a yard where it is still in vogue. In New York the soft mud process is the most used. There are a number of different types of machines but the fundamental principal of them all is the same. A soft mud machine consists essentially of an upright box of wood or iron and generally of a rectangular shape. In this is a vertical shaft bearing several knives horizontally. Attached to the bottom of the shaft is a device such as a curved arm, which forces the clay into the press box. The molds are put in at the rear of the machine and fed forward underneath the press box automatically. The empty mold sliding into place shoves out the filled one. A boy sands the molds before placing them in the machine in order to prevent the clay from sticking. The clay is fed to the machine at the upper end of the box. Often there is a pug mill attached to the machine. In all these machines the material gets an additional amount of mixing by the knives on the vertical shaft. In

fact many brick manufacturers consider that the soft mud machine tempers the clay sufficiently to enable them to dispense with a pug mill or ring pit and use the old-fashioned soak pit. That they can make a very fair common brick thus is not disputed, but it is certain that with a thorough tempering of the clay, a better brick would be obtained in most cases. There is one type of machine, the Adams, used by several manufacturers on the Hudson River, which does not temper the clay, but simply forces it into the press box. Some form of tempering machine must, therefore, be used in connection with it. These soft mud machines have a capacity of about 5000 brick per hour, six being molded at a time.

Steam power is generally used to run the machines, but some of the smaller yards use horse power; this, of course, is much slower and not economical except for a yard of a small capacity. Some soft mud machines are more powerful than others, and indeed this is necessary. For instance a brick dried on pallets needs a much greater pressure applied to it, and has to be molded from stiffer material than one dried in the sun in the yard.

Four men are required to tend the machine. A "molder" who scrapes off the top of the mold as it is delivered from the machine and watches the consistency of the tempered clay, to see that it keeps uniform; a "mold lander" who takes the mold from the delivery table and places it on the truck; a "sander" who sands the molds before putting them in the machine, and a boy to watch the machine and stop it when necessary. Besides this there are four "truckmen" who wheel the bricks from the machine to the yard where they are dumped on the drying floor by two "mold setters." In the afternoon these men are emp oyed in hacking the bricks and wheeling the dry ones to the kiln.

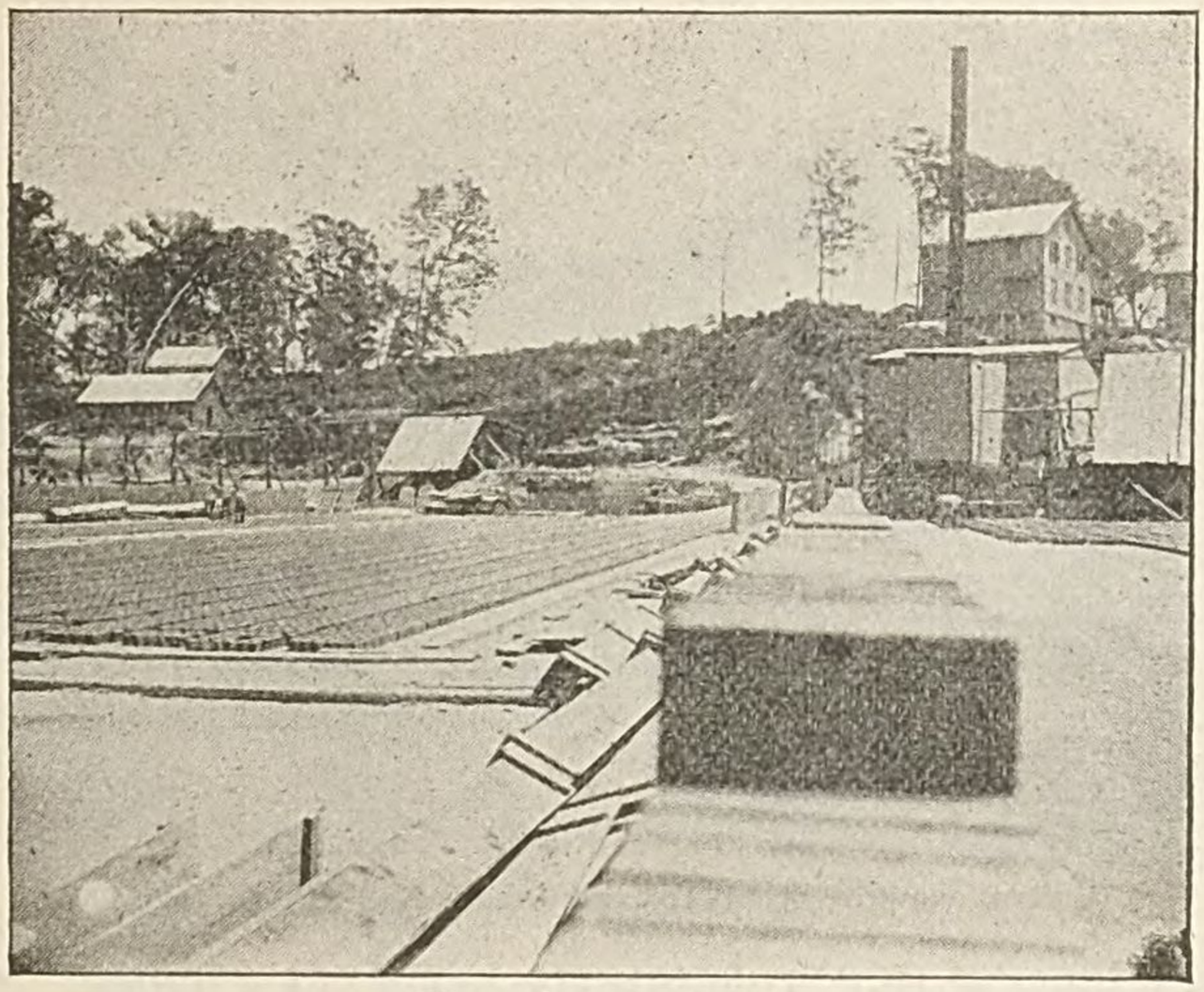
*Drying* — In New York State bricks made by the soft mud process are usually spread out on floors or set on pallets to dry. A few yards use tunnel dryers, but as these are more extensively used in connection with the stiff mud process they will be described there.

Drying should not be hurried. Bricks dried too quickly are apt to crack. They should also be well dried before setting in the kiln, and if this is not done the product is very apt to be poor.

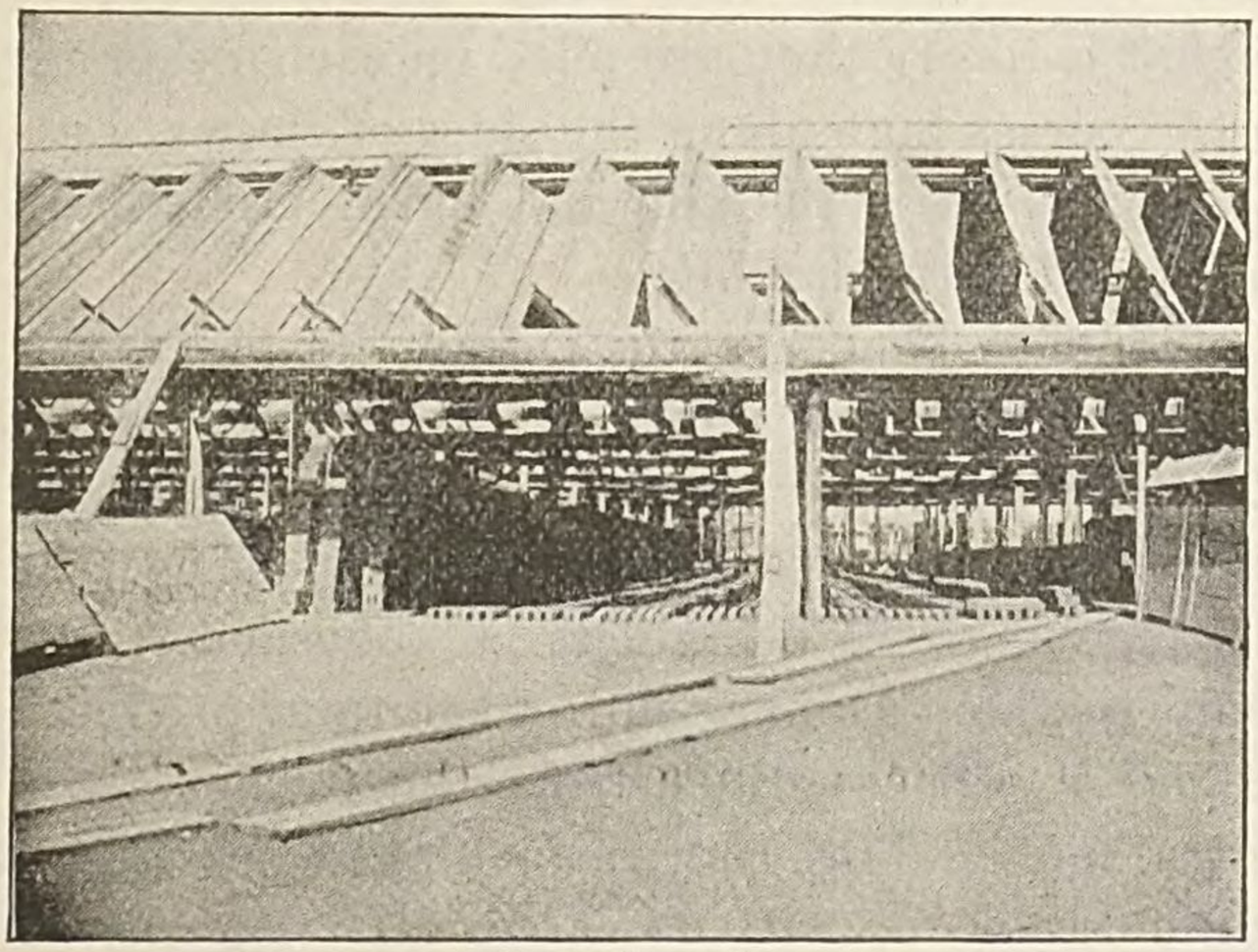
Bricks made by the soft mud process are usually dried in one of three ways viz.:

1. Open yards
2. Pallet yards
3. Covered yards

The first method is the most used, the second next and the third least. In the first method the bricks are spread out on a hard



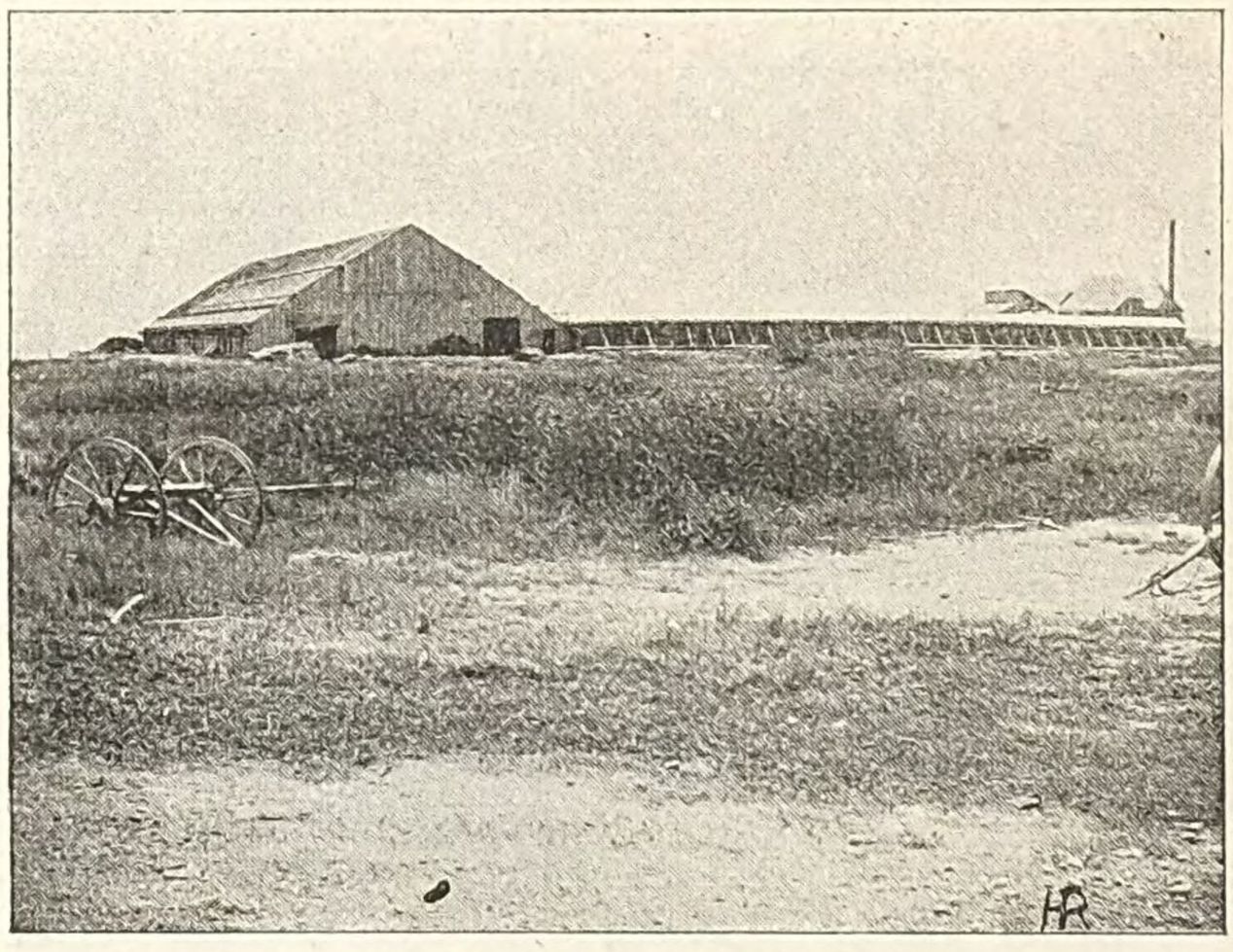
View of open yard.



Covered yard.

floor, in the open air. This floor, which is about 200 feet long, is of brick, with a thin covering of sand, and is the "yard" proper. At one end of it are the molding machines, at the other end the

kiln sheds. The yard usually drains toward one end, or from the center toward both. After a day's production has been spread out the boy who tended the machine in the morning goes along the rows and stamps them with a piece of board set on the end of a long handle. This is termed "spatting." After this the bricks are turned on edge by another boy who goes along the



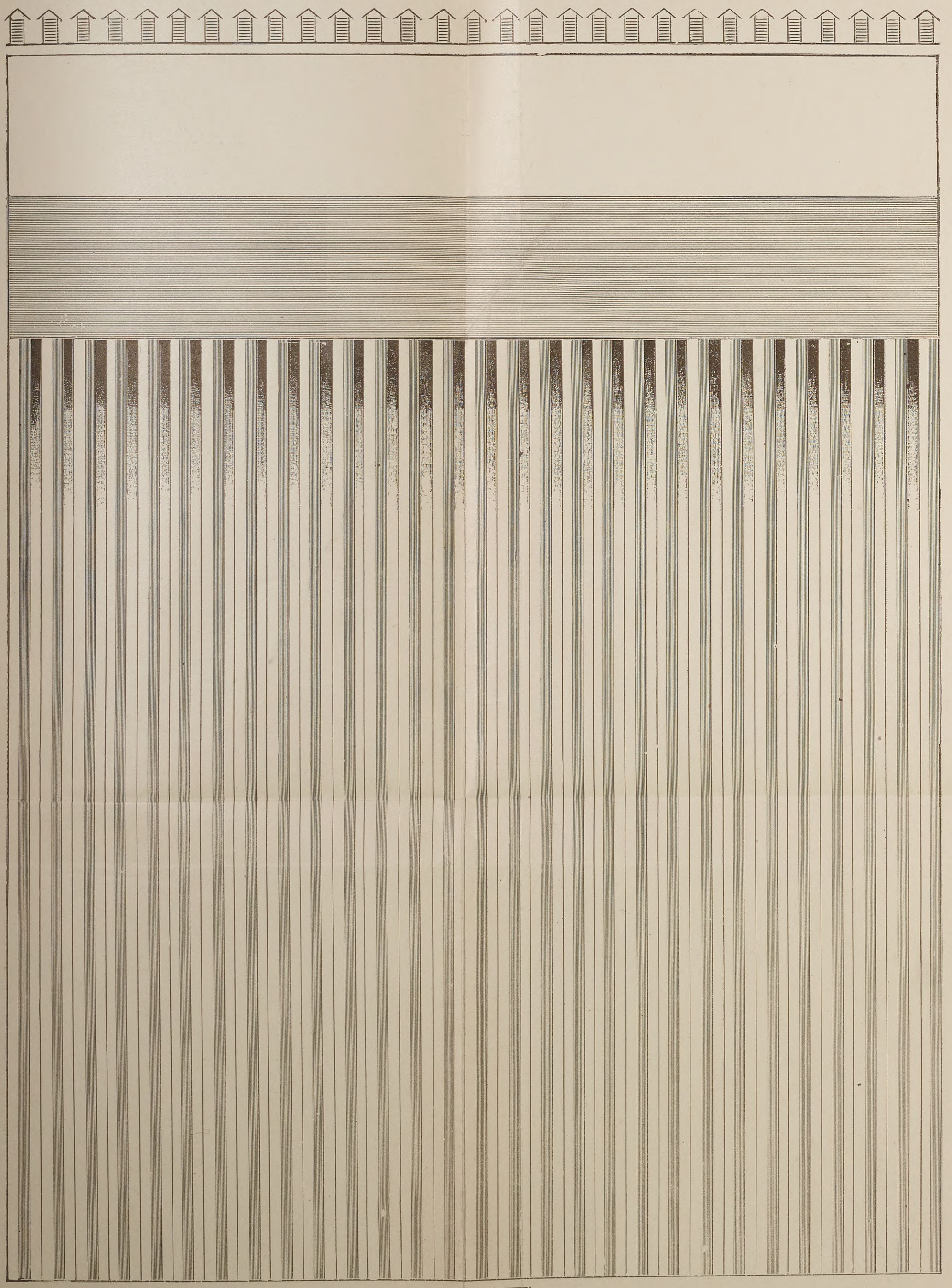
**General view of brickyard, kiln sheds and drying rack.**

rows with a special tool, turning six bricks at a time. The next morning, if the weather has been pleasant, the bricks are "hacked," that is to say they are piled on each other in a double row 11 to 15 courses high along the sides of the yard and left till sufficiently dry to put in the kiln and burn. In case of rain the hacks are covered with planking.

The disadvantage of open yards is that the bricks are exposed to the rain, and if a shower comes while they are spread out on the yard, they become "washed," getting a rough, uneven surface. Washed brick are quite as strong as unwashed ones, but they bring 50 to 75 cents less a thousand. The washed brick amount to about 15 per cent. of the total production. *

*Covered yards.*—These differ from the former simply in the addition of a roof. This roof is in hinged sections, which on pleasant days can be opened upwards, allowing the sunlight to enter, and closed to prevent washing of the brick in case of rain. Washed bricks are of course avoided by this method of drying,

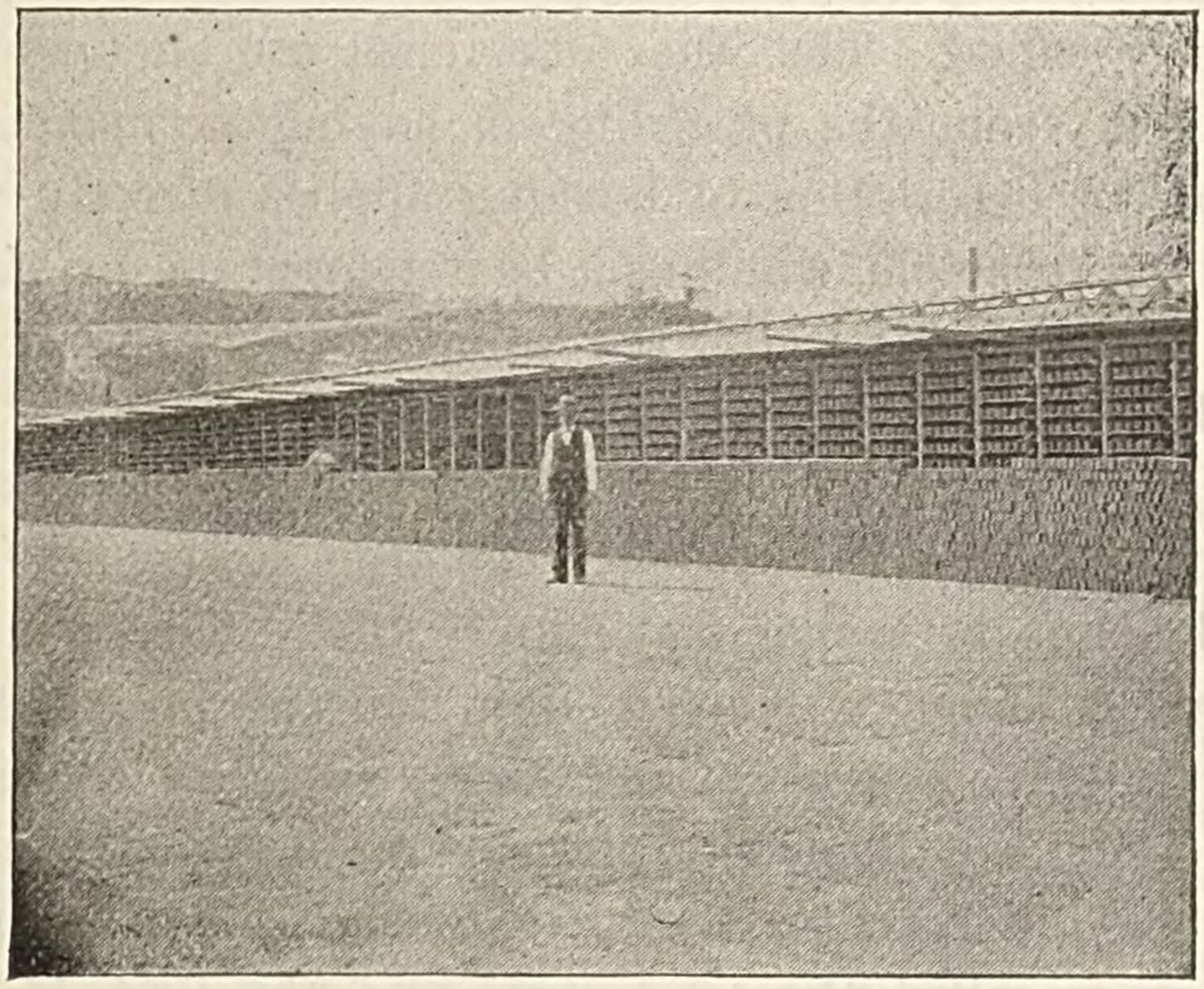
* Quite recently washed brick have been employed for the fronts of buildings. They givea unique effect.




PLAN OF PALLET YARD.

but the bricks do not dry so fast, and, therefore, more drying room is needed for a yard of the same capacity. There is also the expense of erecting the sectional covering.

*Pallet driers.*— By this method the bricks are dumped directly on "pallets" as they come from the machine. These



**Pallet racks.**

latter are pieces of board long enough to hold six bricks. The pallets are then set on racks or cribs until the bricks are sufficiently dry to be set up in the kiln. There are both advantages and disadvantages to this method. As the bricks can not be spattered to keep them in proper shape, they must be firm enough to retain this themselves, consequently the clay must be molded stiffer, and to do this we must have strong machinery. Furthermore, a molding sand must be used which will allow the brick to slip readily from the mold, as it has been forced in tighter than a brick which is to be dried on an open yard. There is, of course, the expense of setting up the racks, but on the other hand the capacity of the yard is increased, the brick, though drying slower, are not subjected to a sudden drying, such as the sun of a hot summer's day is apt to give, and, therefore, perhaps warp or crack the brick. The brick are only subjected to one handling between machine and kiln. Some manufacturers claim that it is cheaper to make bricks on a pallet yard. A machine called a "pallet-squarer" has been invented by Mr. Swain of the Croton Brick Co. which is said to fulfil the

functions of a spatter (*See* detailed account of yards). All clays are not sufficiently strong to permit drying on pallets.

*Burning.*—This is one of the most important steps in the whole process of manufacture. Nine tenths of the manufacturers who make common bricks by the soft mud process, burn them in temporary, up-draft kilns, or scove kilns, as they are properly called. The other one tenth use an up-draft kiln which differs from the preceding in having permanent walls. The following description of burning applies directly to scove kilns, but the principle, whether it be a temporary or stationary up-draft kiln, is practically the same. When the bricks are thoroughly dry, they are set up and burnt in "arches," several of which go to make up a kiln. The number of bricks in an arch varies from 35,000 to 40,000. An arch is about 40 courses high, and about 15 arches make up a kiln. The open portion of the arch is about 14 courses high, and the bricks above the arch are set three one way and then three on top at right angles. They are kept slightly separated by putting small pieces of clay in between them. The first row of brick on top of the arch is called the tie course, and the first 14 courses, including the tie course, above the arch are called the "lower bench," and the rest of the courses above are called the "upper bench." When the arch and lower and upper benches have been set, brick are laid flat over the top of the kiln; this is the "raw platting," and then on top of this is laid burnt bricks at right angles to those of the raw platting; this is the "burnt platting." Hanging from the roof of the kiln shed at the same level are a number of bricks which serve as a guide for height in building the kiln. A wall of two thicknesses of "double-coal" brick is put around the outside of the kiln, scoving the kiln it is called, and this is "daubed" over with mud. The daub is to prevent any air entering except through the doors. These latter consist of an iron frame about 14 inches high, with an iron plate to close the opening; the frames are set in the courses of double-coal brick, at the bottom of the arch on both sides of the kiln. Double-coal brick have six or seven times as much coal dust in them as others, and are used for placing around the outside of

the kilns. The combustion of the coal in them, the manufacturer claims, supplies the necessary amount of heat to the outer portion of the kilns which are not sufficiently heated by the arch fires. Double-coal bricks sell for about $2.50 per 1000, and usually bear some distinguishing stamp, but they are not as strong as the other brick. It takes two setters and four wheelers about one day to set an arch of 35,000 brick; two men will daub the outside of a 15 arch kiln in one day.

Having "walled-up" the kiln with double-coal brick and daubed it over, the next step is to start the fires and burn the bricks. The principle of the process is essentially the same, whether wood, coal or oil are used as fuel.

First, every alternate brick of the "burnt platting" is stood on end to allow the "water smoke" or steam to escape as quickly as possible. A fire is then started in the mouth of each arch. When coal is used the fire is started on the windward side of the kiln so as to allow the smoke to blow through the arches.

The fire is also started from the other end of the arch, and the two fires are then built up slowly till they meet in the middle. The time of crossing the fires varies; with machine-made bricks the fires should not be crossed as quickly as with hand-made ones Along the Hudson the time of crossing is from 40 to 60 hours. The steam should escape evenly all around the top, and the upper limit of the fire should follow directly on it, the steam acting as a blanket, and its lower limit should be even. It is the duty of the foreman to watch the burning carefully, and increase or ease up the steam in any one arch, according as it is coming off too slowly or too rapidly. The fires are increased until the "water smoke" changes to a bluish black smoke, and at this point the fire can be seen at night time coming from the top of the kiln. The kiln is now "hot" and the bricks commence to shrink or "settle" and all the platting is turned down. Up to this point care must be used to gradually increase the heat. The bricks now get their heaviest heat, and the oxides of iron are changed to the anhydrous peroxide, giving the bricks their red color. If the heat in the arches is too great, the bricks run, stick together or become distorted and cracked. After the firing has been done the doors are all closed and plastered over to prevent any air from entering.

If the bricks are put into the kiln before they are sufficiently dried, or if they are heated too quickly, they are liable to crack.

In the case of coal, grates have to be put in a few inches above the level of the floor, and for oil, burners are needed.

After a kiln of bricks has been burned the ends of the arch bricks are often black, caused by the particles of dust and carbon which have been carried upward sticking to the brick when they were in a soft condition, due to the high degree of heat.

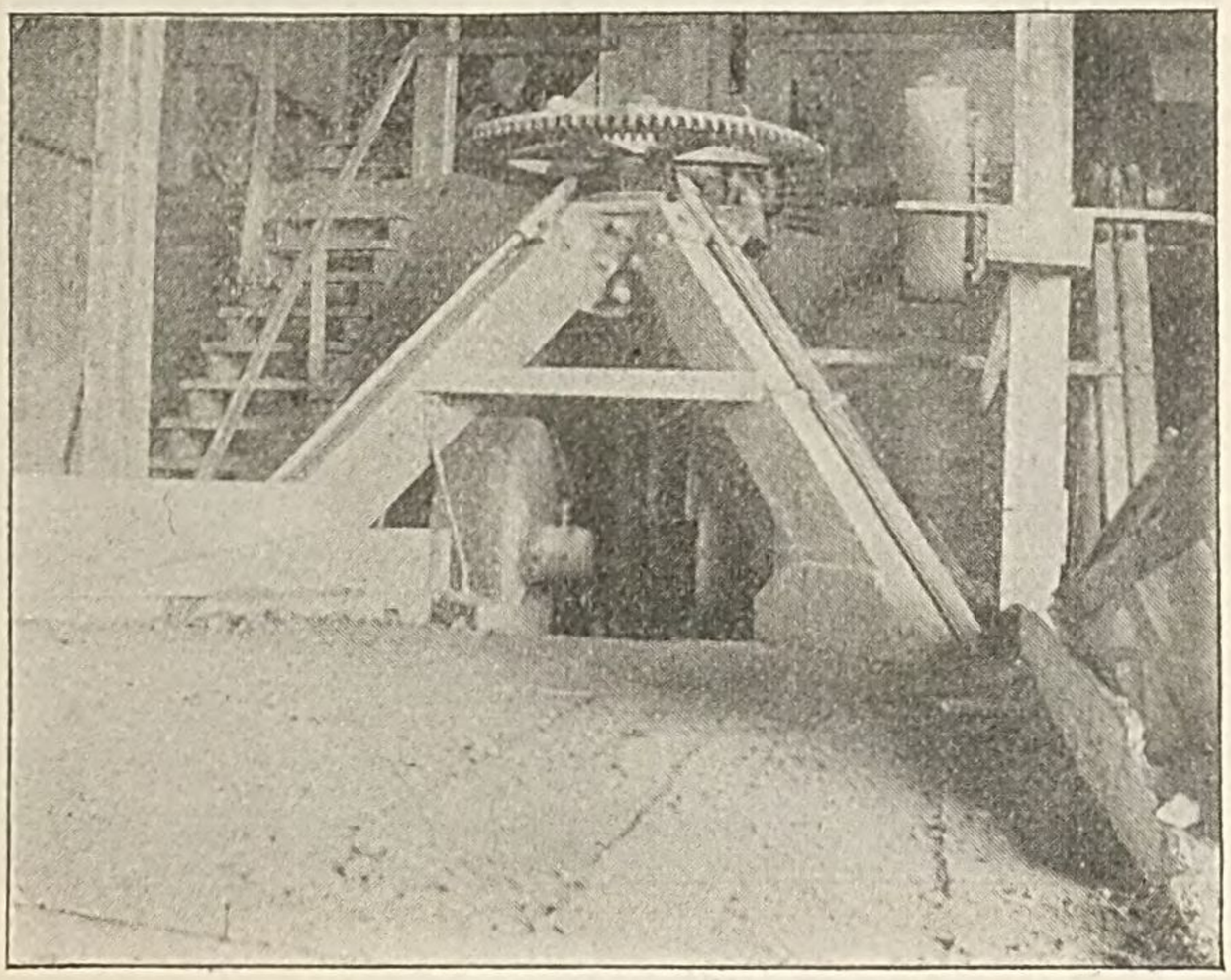
As to the action of the coal dust in the brick. At first while the brick contains water, there is no access for the air to the particles of coal. However, as the firing proceeds, the water is driven off leaving the brick porous, allowing the air to enter for the combustion of the coal. Particles of lime and lumps of clay cause a splitting of the brick. Insufficiently burnt bricks are called "pale" and sell for $3.75 per 1000.

The kilns take several days to cool, and, when cool, the bricks are put on wheelbarrows, and taken to the freight cars, or barges, and then shipped to the market. If the kiln shed is not situated along the dock, the barrows are put on a car, which is run down a track to the scow. The time of burning is from five to seven days with wood and four to five days with oil. The cost of burning with wood is 60 to 75 cents per 1000 brick, and with coal the cost of burning is 40 to 50 cents per 1000. Burning with wood is the cheapest method as far as implements are concerned. With coal there is the cost of grates and with oil there is a royalty of $160 to be paid on every burner. The latter is, however, the cheapest method as regards the price of fuel. The great majority of the yards along the Hudson use wood, a few use coal and two or three use oil. With coal and oil the heat can be better regulated than with wood. Another important point is the amount of pale brick produced. Most of the yards in New York burn their bricks in scove kilns. In these there is sometimes a loss of as much as 50,000 to 75,000 in a clamp of 500,000 bricks, while in a permanent kiln such as the Wingard or similar, the amount of pale brick is said to be not over 25,000 usually. Again in the case of permanent kilns, it takes no more, if not less, time to set the bricks and there is less daubing to be done. Regarding the amount of labor required in burning, one man is supposed to tend three arches.

## Stiff mud process

This is so called from the fact that the clay is molded quite stiff, being forced from the machine in the form of a hard bar which is cut up into brick.

The clay is sometimes prepared in pug mills which have been previously described, but pan crushers are mostly used for this purpose in New York.



Pan crusher.

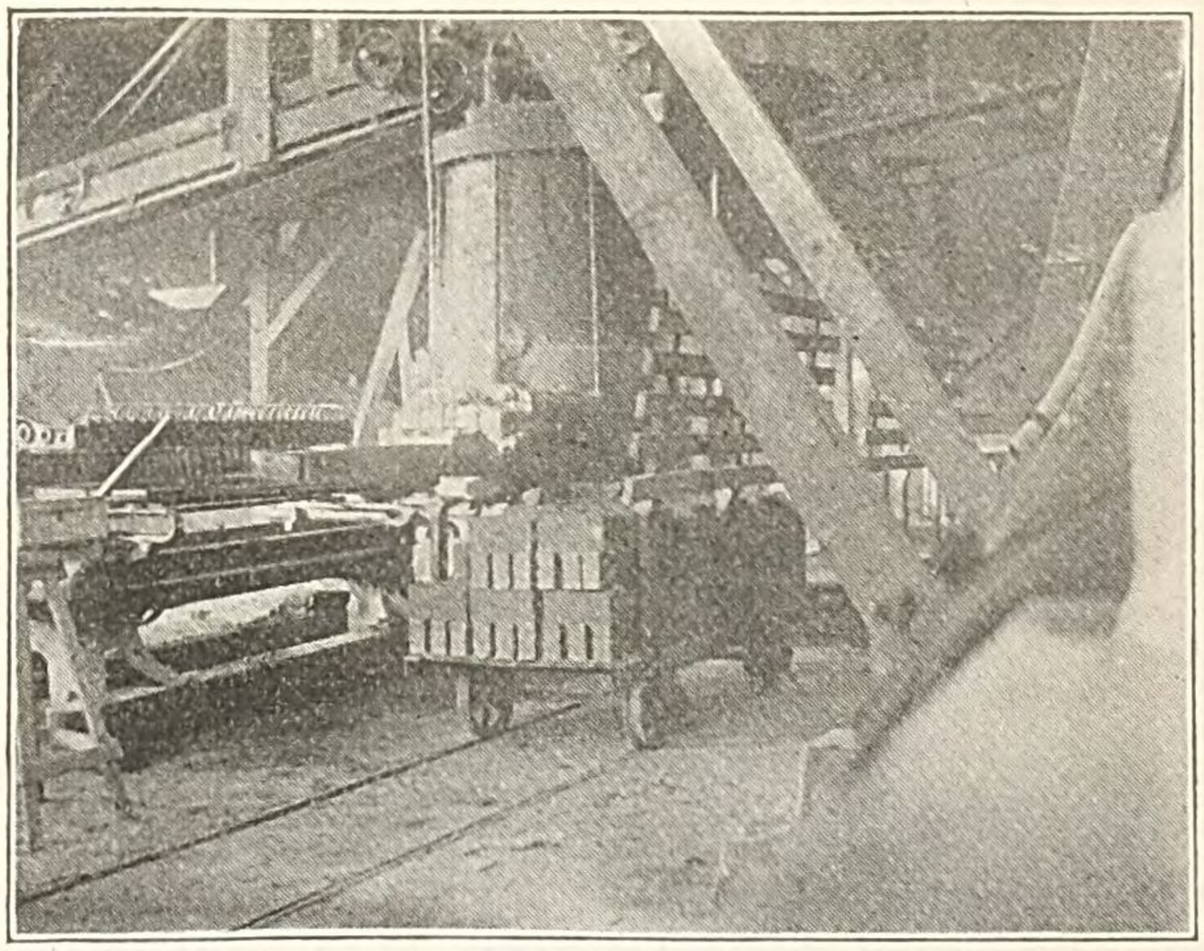
*Pan crushers.*— Of these there are two classes, viz : Dry pan crushers and wet pan crushers. The former pulverizes the material as it comes from the bank, the latter tempers it with water. In either case the crushers consist of a circular pan in which there are two iron wheels revolving on a horizontal axis. They are made to revolve by friction against the pan which is rotated by steam power. In a dry pan the bottom is perforated and the wheels weigh 2000 to 5000 pounds each. The wet pan has a solid bottom, in which there is a door through which the material can escape when sufficiently tempered.

A good dry pan will grind 100 tons in 10 hours through one-eighth inch screens.*

Two scrapers are placed in front of the rollers to throw the material in their path. In a wet pan water is added to the clay

* E. Orton, Jr., Clay Working Industries of Ohio, 1893, p. 142.

and when a charge is sufficiently tempered it is removed either through a door in the bottom of the pan, or else by means of a shovel attached to a long pole and pivoted on an upright support. Wet pans are more expensive than pug mills and require more power to operate, and they do not temper the material as evenly. They are, however, better adapted for tough and shaly clays.

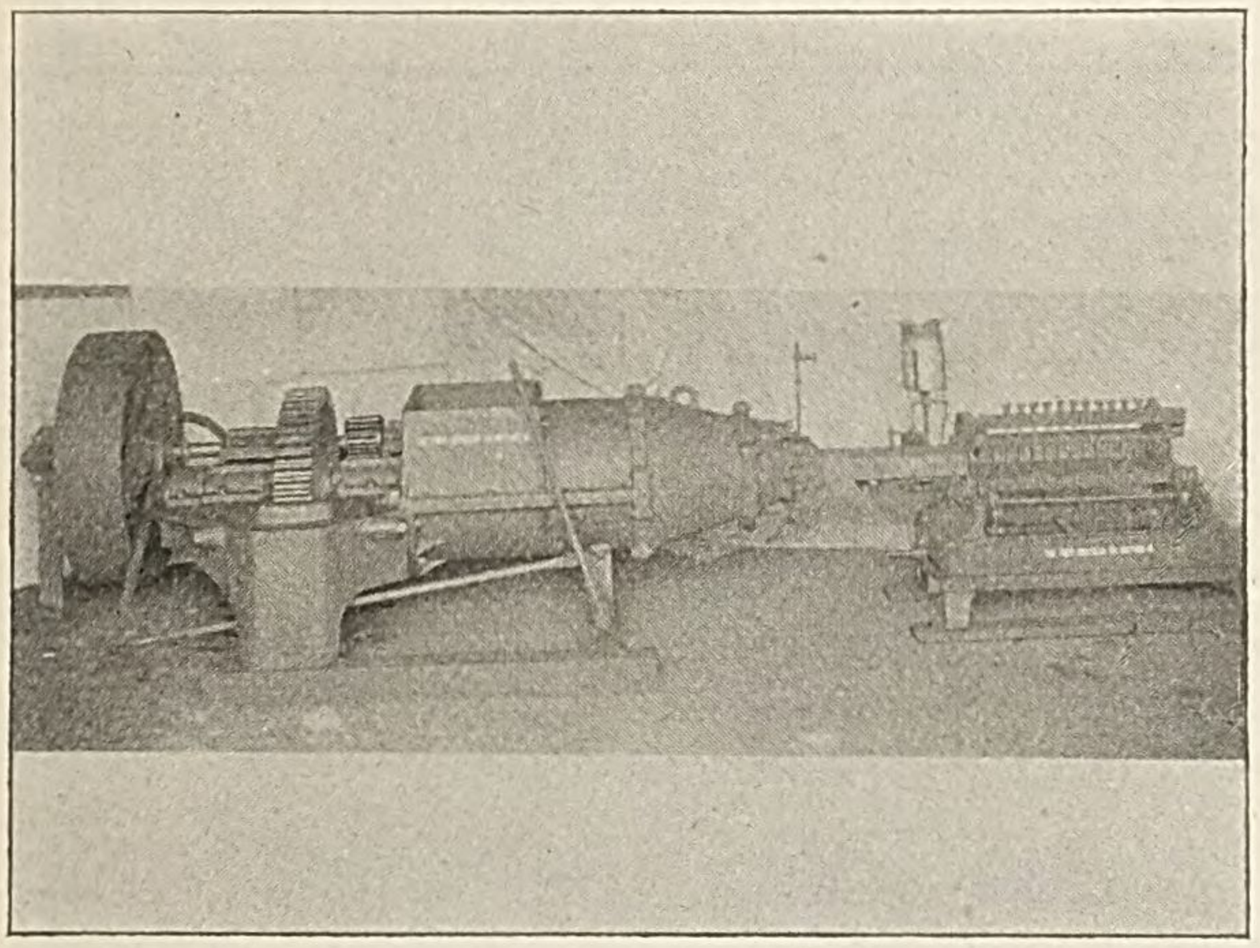


Stiff mud, wirecut machine.

*Stiff mud or wirecut machines.*— Their name indicates the nature of the process. The clay is tempered quite stiff, and charged into the machine from which it is forced in the form of a rectangular bar whose cross section has the same area as the greatest plane surface or end of the brick. The bar of clay as it issues from the machine is received on the cutting table, and is cut up into brick either by means of a series of parallel wires set in a frame which slides across the cutting table, in which case the machine stops when the bar has issued a certain length, or else the bar of clay issues continuously, and is cut up by means of wires on a revolving frame. The former method is usually employed in connection with the plunger type of machine and the latter with the auger type.

The plunger machine consists of a large iron cylinder into which the clay is charged, and from this it is forced out through the die.

The auger machine consists of a cylinder with a conical end. In this is a horizontal shaft bearing a screw or knife blades so set that their action will force the clay forward. At the forward end of the shaft is an iron screw which forces the clay out through the die. The clay is fed at the large end of the cylinder. It will thus be seen that the clay undergoes a large amount of compression and

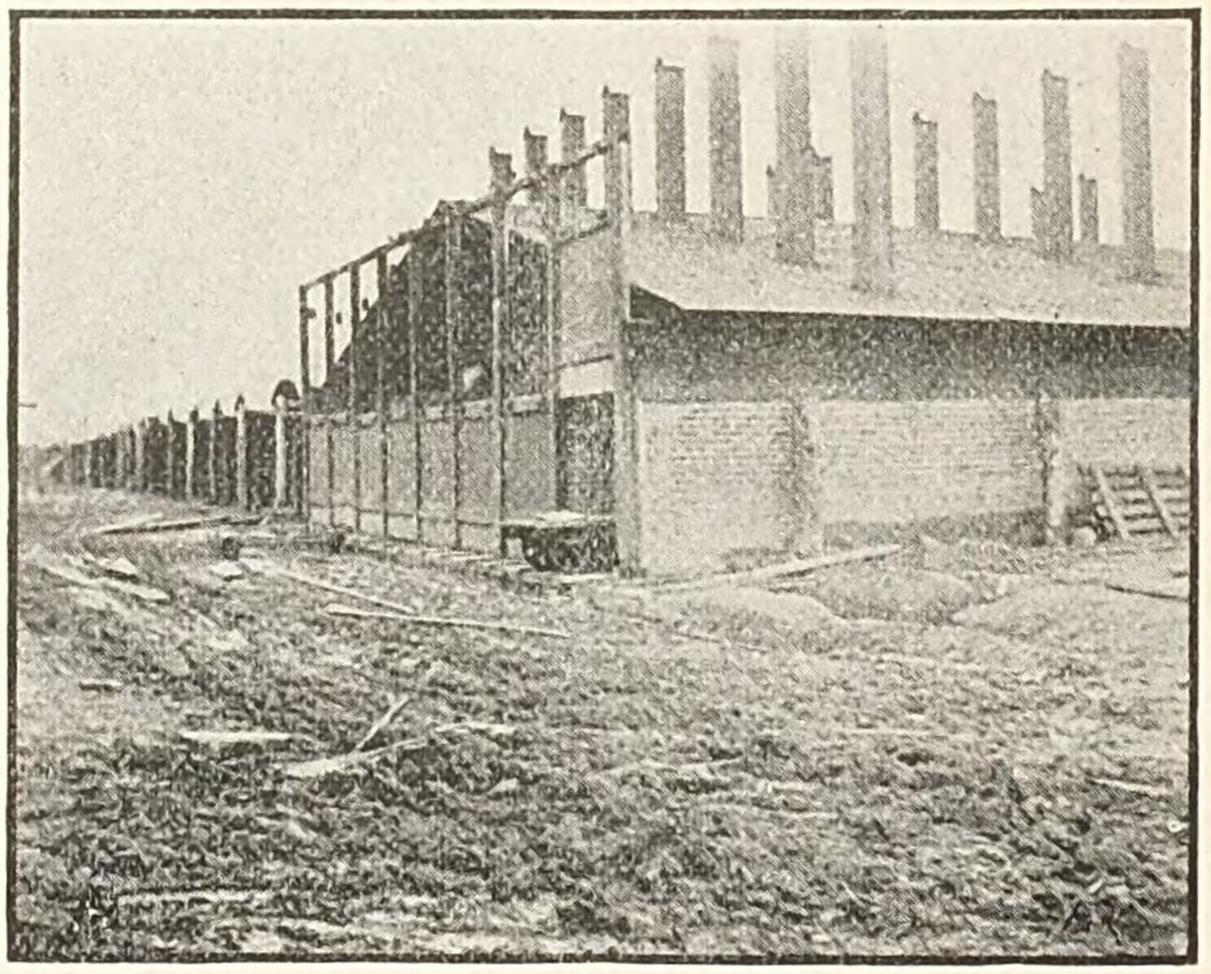


Auger machine.

that considerable power is required to force it through the die. Auger machines are either end cut or side cut according as the area of the cross section of the bar is the same as the end or side of a brick. The great objection to this form of brick machine is the spirally laminated character which the brick has, owing to the manner in which the clay is forced through the die. Nevertheless this machine is extensively used at the present day, especially in the manufacture of paving brick. It has a large capacity, 60,000 brick being not an unusual output for 10 hours. The capacity of the auger machine is often increased by causing two streams of clay to issue from it and certain machines are said to have produced 150,000 brick per day. Plunger machines have a capacity of 25,000 to 30,000 per day.

The green bricks are usually piled on cars and these are run into heated tunnels to dry. If soft mud bricks are dried in tunnels then the cars must have racks on which to set the pallets bearing the bricks. Stiff mud bricks can, however,

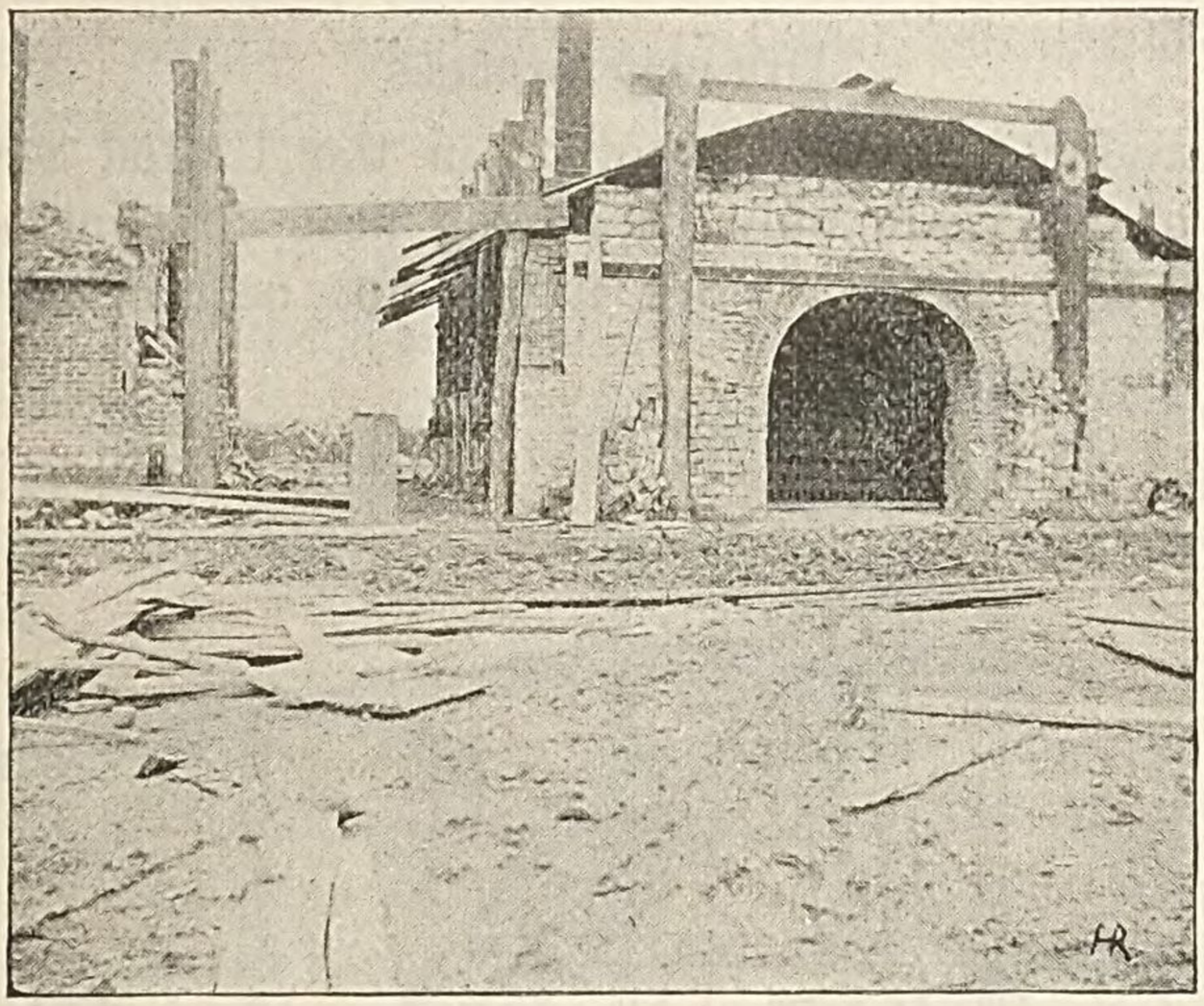
be set on each other setting the bricks of two successive courses at right angles to each other. Each car carries about 360 brick. Tracks are laid from the machines through the tunnels to the kilns. The tracks are laid in two directions only, at right angles to each other, and turn tables are placed at the points where tracks intersect. The tunnels are built of brick or wood. They are about five feet high and four feet wide. Several methods



Tunnel dryers.

are used to heat the tunnels. There may be a fireplace at one end and a system of parallel flues under the tunnel to conduct the heat. A second method is to use steam heat, the pipes being laid along underneath the floor of each tunnel or along the sides. Exhaust steam is used in the day time and live steam during the night. Another method is to heat the tunnel by a hot blast. In a good dryer the natural draft should be sufficient to draw the air through the tunnels. Six or more of these drying tunnels are usually set side by side. Artificial drying takes from 24 to 36 hours. The green brick are put in at the end nearest the machine and the cars with the dry ones drawn out at the opposite end. It is of importance that the capacity of the dryers should not exceed that of the kilns. Artificial dryers have the advantage of permitting a plant to be run all winter. The cost of flue dryers is set at 25 cents a thousand brick with coal at $2.50 per ton.

Scove kilns, clamps or down-draft kilns are used for burning the product. The principle of burning is much the same in all three, although many manufacturers claim that the burning can be better regulated in clamps and down-draft kilns, while others claim the opposite. In the latter the bricks in the upper portion of the kiln receive the greatest amount of heat, whereas in a



Down-draft kiln.

scove kiln or clamp the arch bricks, which have to bear the weight of the overlying bricks, are heated the most and often become crushed out of shape. Regarding the rectangular and circular down-draft kilns, the latter are bound easier than the rectangular ones, this being of course necessary in order to prevent a bulging of the walls during burning.

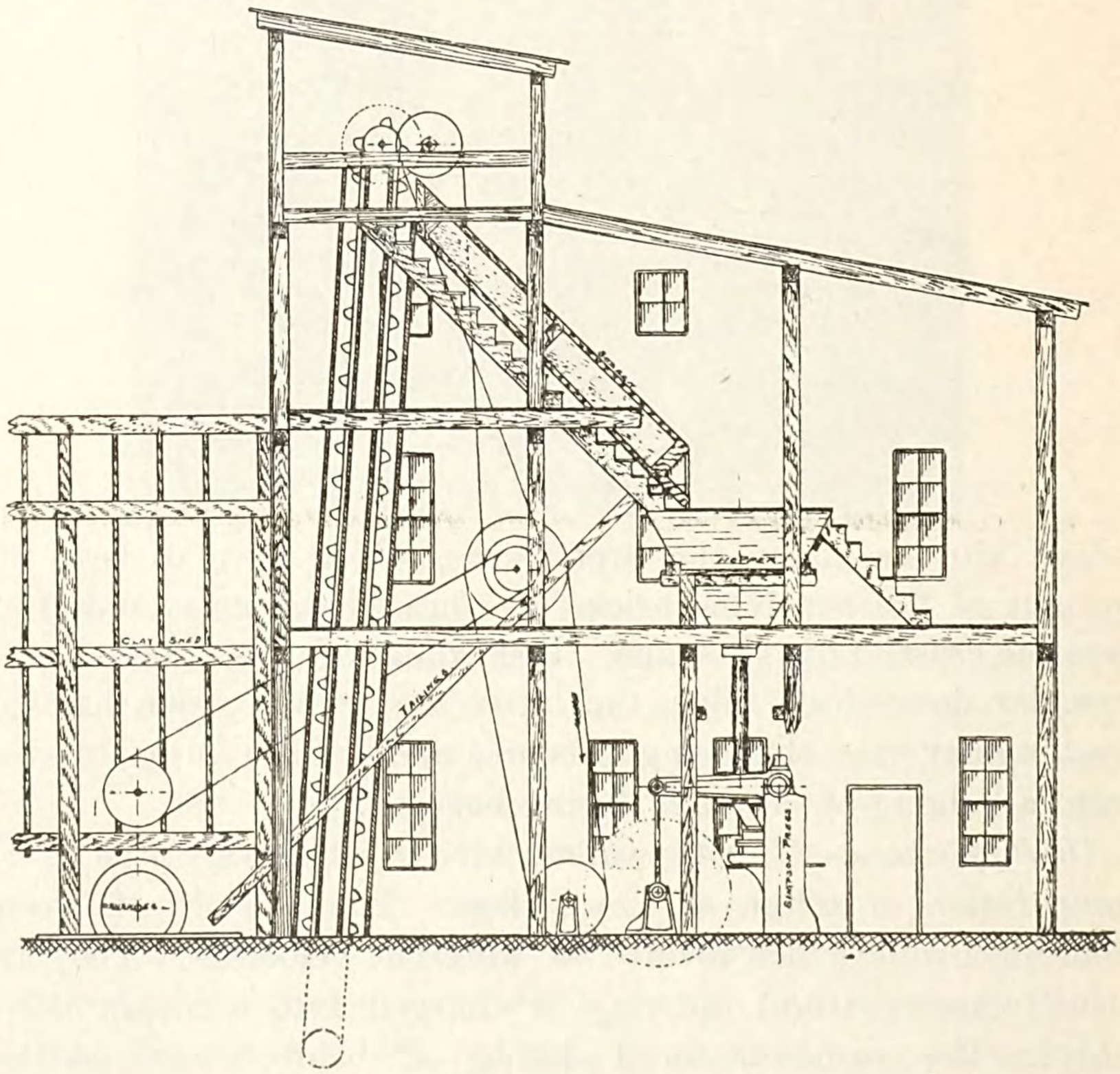
*Roll crushers.*— This type of machine is extensively used in the preparation of tough or stony clays. They consist of two or four steel rolls, which revolve at different velocities. They are usually enclosed and the clay is charged into a hopper above them. The crushed material passing out below is received on a traveling belt and carried to the pug mill. Crushers are objected to by many on the ground that they make the clay flaky, in which condition it does not make a good brick. Subsequent pugging, however, usually does away with this. By many manufacturers rolls are used as a means of breaking up the stones and thus avoid drying the clay and screening it. There is no

special objection to this unless the pebbles are limestone and then they should not be allowed to enter the brick. Several forms of machines have been invented which, it is claimed, break up the clay and separate the pebbles at the same time.

Barrel sieves are sometimes used to get rid of pebbles in the clay. In this case the clay has to be first dried and broken up.

### Dry clay process

The introduction of this method in the United States dates back 15 or 20 years only, it having been first introduced at Louisville, Ky. In New York it has not been in use over five




Dry clay plant.

years, and there are only five machines in use in the state. The clay after being dug is usually stored in sheds to dry. When ready for use it is taken out and charged into the disintegrator or dry pan, preferably the latter. Dry pans have been described in connection with the stiff mud process; as to disintegrators the

New York brickmakers use a Steadman. It consists of a cylindrical flat box about three feet in diameter, within which two concentric wheels with iron arms revolve at a high rate of speed; the clay being thrown around between these is quickly broken up. If the clay is charged in too moist a condition it will not be thoroughly pulverized, at the same time it must not be charged too dry and thereby prevent the particles in the green brick adhering together. After passing from the disintegrator the powdered clay is carried by an elevator to the upper story where it is discharged onto a long screen inclined at an angle of about 45 degrees. The material which has been ground fine enough passes through the sieve and down into the hopper over the molding machine. The tailings fall into a hopper at the lower end of the sieve and are carried back to the disintegrator.

Now comes the molding, the manner in which it is done characterizing the process. The molding machine consists of a massive frame of forged steel about eight feet high. Three feet up from the ground is the delivery table, sunk into which is the press box. Connected with the hopper above the machine by means of two canvas tubes is the charger. This latter slides back and forth on the table. It is filled on the backward stroke and on its forward stroke lets the clay fall into the mold box. The charger then recedes to be refilled and at the same time a plunger comes down pressing the clay into the mold. As the upper plunger descends a lower plunger which forms the bottom of the mold moves upward, so that the clay receives pressure from above and below. The upper plunger then rises, and the lower plunger ascends until the lower surface of the brick is even with the table. Again the charger comes forward, shoving the green brick forward on the table, the lower plunger drops and the mold box is once more filled with clay. The faces of the mold are of hard steel heated by steam to prevent adherence of the clay. Air holes are also made in the dies, but are apt to become clogged up. The pressure from above is applied by a toggle-joint arrangement, and it is claimed by the manufacturers of the Boyd dry clay presses that the pressure exerted on each brick is 150 tons. One to six bricks can be molded at a time, according to capacity of machine. On a four-brick machine about 20,000 are molded in a day. As the

molded brick are shoved forward on the table by the charger they are placed on cars and either taken to drying chambers or set directly in the kiln The green brick require great care in handling as they are very tender. Drying must be done very slowly to prevent cracking. Burning is usually done in down-draft kilns. The manner of burning does not differ essentially from that followed for other makes of brick. By setting directly in the kiln without previous drying it takes longer to water smoke. This in any case should be done very slowly and the burning should not be pushed until water smoking is entirely finished. It is claimed by some that one sixth to one quarter more fuel is required to burn dry clay bricks than those made by other processes.

The type of kiln used varies.

## Cost of production

This item varies considerably depending on a variety of circumstances, such as the method of manufacture employed, cost of labor, locality, etc.

Brick manufacturers are generally unwilling to give information on this subject, and the figures given, therefore, can only be considered approximate.

The use of improved machinery and methods will often lower the cost of production considerably, but this generally requires a much greater outlay of capital than seems to be in most instances available.

By the hand power method the cost of manufacture is $3.75 to $4.00 per 1000 delivered at the yard. On Long Island where the soft mud process is almost exclusively used the cost is said to be $3.00 per 1000 delivered at the yard. Hudson river manufacturers quote the cost at $5.00 per 1000 delivered in New York city; this figure includes $1.25 for transportation and 25 cents per 1000 for commission.

The brick yard is usually owned by the manufacturer but the clay bank is worked on one of the following bases:

1 The manufacturer owns the bank. This is by far the best and most profitable arrangement.

2 The brickmaker pays a certain rental, usually nine or 10 per cent.

3 The owner of the clay bank gets so much per 1000 brick. At Haverstraw this varies, for instance, from 25 cents to $1.25 per 1000. With this arrangement the manufacturer is bound to a certain amount of production.

Of the three methods for manufacturing brick, the soft mud process is the cheapest as far as first cost of plant is concerned, but it is probably not the cheapest to operate, as more labor is required. The other two methods used, the stiff mud and dry clay, require considerable outlay of capital. Less labor is required for operating either of the last-mentioned plants. The actual cost of production by either of these methods I have not been able to obtain. It is doubtful if the dry clay process is the cheapest, as the manufacturers of this class of machinery claim, for the economy gained, due to the shortness of the method, is probably counterbalanced by the increased time of burning and consequently greater amount of fuel used. With the soft mud process one man per 1000 brick is what the manufacturer figures, that is, if the yard has a capacity of 50,000 per day, a force of 50 hands is required to operate the yard.

As regards fuel, for instance, a saving of 30 cents can easily be made by using coal instead of wood, and gas is considered about 25 cents cheaper per 1000 than coal. Further economy may be made by the use of the proper class of machinery for haulage. Carts can usually be used economically up to 400 feet, beyond this it will usually pay to lay tracks and use cars hauled by horses. Above 600 feet steam haulage has been found economical. Self-acting planes and cable haulage have been used to advantage in a few instances.

## Detailed account of brick yards

As the brick yards are scattered all over the state, a division of them into groups for convenience is more or less arbitrary. However, the following classification has been made.

Brick yards of eastern New York
" " " central New York from Schenectady to Buffalo
" " " Oswego, Jefferson and St. Lawrence counties
" " " southern New York
" " " Long Island
" " " Staten Island

Most of the bricks manufactured are sold in local markets. The greatest proportion of the Hudson river ones, as well as some of those made on Long Island and Staten Island are sold in New York city. Other large markets are Buffalo, Rochester, Syracuse and Albany.

*Croton Landing*, Westchester Co. There are three yards, all situated on Croton Point and having a yearly capacity of 61,000,000 brick. The yards of the Anchor Brick Co. are situated at the base of the p( int, a short distance south of the station and along the railroad track. One yard is situated a few feet above river level, the other 90 feet above it on a delta terrace. The clay deposit adjoins this yard. It is basin-shaped, and varies in depth from 40 to 70 feet. The clay is mostly blue, and is underlain by hard pan, the pebbles of which are cemented by clay stained with limonite. The present excavation is about 40 feet deep; the bottom of it is 40 feet above mean tide. Borings show an additional depth of 35 feet in the center, and the engineer who made them calculates that at their present rate of manufacture there is sufficient material in sight for 15 more years. The stripping amounts to about 10 feet of loamy clay and sand. Streaks of gravel are not uncommon in the clay.

The deposit is worked in benches having a long working face and these benches converge to one point at the eastern end of the pit, from which a single track is laid up to the tempering machine. Tracks are also laid along the benches, and as the working face recedes the tracks are shifted with crowbars. The cars are brought down to the working face by gravity, or a small engine which is chiefly used to draw them to the tempering pits. A temporary track is laid over the ring pits, upon which the cars can be run to facilitate dumping. Those cars containing clay for the lower yard are run on to a self-acting inclined plane, and on this the empty cars, and tempering sand for the upper yard are also brought up. The tempering sand is dug by a steam shovel, at the base of the terrace escarpment The bricks are dried on covered yards and burnt in a special type of kiln. It consists of two walls of best quality brick, about 15 feet high and 14 inches thick. The lower portion containing the doors are two feet thick, and the two walls are about 20 feet apart. The two ends have to be walled up with double coal

bricks after the kiln is filled. Coal is the fuel used. The bricks when burnt are loaded on cars and run down to the dock, those from the upper yard going on the gravity plane. The tempering sand is discharged by the shovel into small cars which are drawn up an incline to the top of a framework and dumped, the sand falling through a series of screens into cars below.

The Croton Brick Co. has two yards; an open and a pallet yard. They obtain all their clay from the river with a scoop dredge. It is dumped into cars on a scow, which when full, are run up an inclined plane on the shore and dumped. The clay is thus exposed to the weather for several months before it is used. It costs about 15 cents per cubic yard to deliver the clay on shore and 10 cents per cubic yard to haul it to the pits. Tempering sand is obtained from the escarpment of the delta terrace just south of the yard. At the pallet yard they use a hand machine to square the green bricks on the racks. It consists of two plates of steel, attached to which at right angles and on the same side of the plates, are 12 smaller ones, the height of a brick. Attached to the large plates are two handles. The two large plates slide back and forth on each other and so that the small plates can be brought together. This machine is set on six bricks at a time and by moving the handles the plates press against the brick, squaring the corners. It is said a boy can square a pitful of brick (35,000) in a day. The molding machines have an endless chain with buckets attached to them for feeding the sand. This leaves only the clay to be shoveled into the machine, and the feeding of the two uniformly and continuously gives a more evenly tempered mixture. It will be seen in this case that no soak pit or ring pit is used and the molding machine does all the mixing. The molding sand is dried by spreading it out on the kiln floor, it being claimed that it dries quicker this way than if it were banked up against the kiln as is commonly done.

The W. A. Underhill brick yards are situated midway between the base and end of Croton Pt. They have two yards, both covered ones. The brick made at this yard are sold mostly for fronts, selling for $14 a 1000. The clay bank lies between the two yards; it has a height of 40 feet above mean tide and extends 15 feet below it. At this last-mentioned depth the blue clay stops and is followed by two feet of yellow clay, several inches of quicksand and through which spring water enters and

finally hardpan. There is a stripping of fine sand, which varies from 10 to 20 feet in thickness. Some portions of this sand are found to make a better brick when mixed with the clay than others. The clay is mined in benches, and narrow tracks are laid along the working face. Side dump cars are used to haul the clay, being run in trains of three, drawn by four mules. The tracks are laid around the ring pits, so that the clay may be easily discharged into them.

Below are given two partial analyses of clay from this bank:

| | Upper Blue clay. | Lower Blue clay. |
|---|---|---|
| Silica | 62.30 | 57.74 |
| Alumina | 14.663 | 26.31* |
| Peroxide of iron | 9.2 | 4.6 |
| Lime | 3.98 | 2.93 |
| Magnesia | 1.05 | 1.4 |

*Crugers, Montrose and Verplank, Westchester Co.*—These three localities lie so connected and their clay banks are so similar that they are best described together. The clay is extremely variable in depth, due to the great irregularity of the face of the underlying rocks; it is both blue and yellow. No special method is used in mining the clay, it being dug at any convenient spot till the underlying rock is reached and then the bank is attacked at another point. At Montrose and Crugers the clay is overlain in places by a moderately fine sand and gravel, crossbedded in places. The clay varies from six to 50 feet in thickness. It extends in places to an altitude of 90 feet, as at McConnell and O'Brien's bank, while at others as McGuire's bank it only reaches a height of six feet above mean tide. At this latter locality the clay is overlain by 10 feet of sand and coarse gravel and has been excavated to 10 feet below mean tide.

A partial analysis of the buff clay from McConnell and O'Brien clay bank at Verplank is given below:

| | |
|---|---|
| Silica | 50.92 |
| Alumina | 26.87* |
| Peroxide of iron | 4.90 |
| Lime | 2.52 |
| Magnesia | 1.56 |

* Alumina is probably too high.—*H. Ries*

King and Lynch's yard is situated on George Point near Montrose. The bank is about 700 feet distant, and the clay is hauled in cars drawn by horses. At most of the yards the haulage is down grade. Fisher's clay bank at Crugers is overlain by two feet of loam. This is used to supply part of the tempering material and the rest is obtained from Jones' Point. At the yards on Verplank Point horse power is chiefly used to operate the machinery. Most of the yards at this locality obtain their clay from the pits of the Hudson River Brick Co. This clay bank is worked in benches. The haulage distance is about one half mile. It is done either in carts or else in cars run on tracks and drawn by horses.

Along the New York Central Railroad tracks a short distance south of Montrose station are the yards of C. Hyatt and J. Morton. Mr. Morton also has a covered yard on Verplank Point where front brick are made. Their banks are practically a continuation of each other. The clay is both blue and yellow and is overlain by several feet of coarse sand. Hyatt uses steam power and Morton horse power to run his machinery. The bricks are loaded on cars and shipped to various points along the Central Railroad.

*Peekskill*, Westchester Co. Bonner & Cole's brick yard lies between the river and the railroad about three quarters of a mile south of Peekskill. The clay lies below tide level. It is claimed that borings have shown a thickness of 50 feet. There is on the average a stripping of five feet of gravel and cobble stones.

South of this yard are two others, viz., Oldfield Brothers and the Bonner Brick Co. Their clay is similar to Bonner & Cole's, but rises to a greater height above tide level.

*Haverstraw*, Rockland Co., is one of the great brick manufacturing centers of New York state, there being forty-two brick yards, with a yearly capacity of 238,000,000 bricks. The yards are situated in a line along the river stretching from the lower end of Haverstraw Village northward around Grassy Point, to Stony Point. A few of them are situated along Minisceongo Creek. Most of the yards along the river are digging their clay below tide level. At the south end of the village a dam was built

at an expense of $30,000, reclaiming thereby 12 acres of clay land from the river. This last-mentioned bed of clay is underlain by till and modified drift, from which tempering sand is obtained. The clay within this enclosure has been excavated to a depth of 20 feet below mean tide. In the pits of the Excelsior Brick Co. they have reached a depth of 35 feet below river level; in Donnelly & Son's pit, 45 feet, and west of Washburn's yard, 40 feet. A pipe well was sunk from mean tide level 100 feet through blue clay, in the Excelsior Co.'s clay, and at this depth struck bed rock or a large bowlder.

The clay in these pits is rather sandy on top, but is said to improve with the depth. It is mostly blue. Streaks of quicksand are always liable to be encountered. In those pits situated along the river and to the rear of the yards, there is no expense of stripping unless the excavation is widened, but there are two important items of expense, viz.: pumps to keep the water out of the pits, and the maintenance of corduroy roads leadingd own into the pits. The clay is dug at any convenient point within the excavation and hauled in carts to the yard. About one quarter mile west of the river, where the terrace is 40 to 50 feet high, clay is being dug from the escarpment to supply the yards of J. D. Shankey, Buckley & Carroll, Phil. Goldrick, R. Malley, and J. Brennan. Some of the yards situated on Minisceongo Creek have to haul their clay 400 to 500 yards. Where the clay is obtained from the terrace escarpment there is in most cases a stripping of from six to 10 feet of sand and gravel. This is screened and used for tempering. The Excelsior Co. has tried to use clay dredged from the river, but gave it up after one season's trial for reasons unknown. Most of the brickmakers at Haverstraw temper their clay in soak pits and burn their bricks with wood. They all use open yards for drying except the Diamond Brick Co. which has recently put in a tunnel drier. The Excelsior Co. have a covered yard and Bennett, Rowan & Scott used pallet dryers. At most of the yards the barges can be brought to within a few feet of the kilns, and those yards not situated directly on the water, put the barrows loaded with brick on flat cars and run them down to the dock.

*Stony Point*, Rockland Co. This is practically a part of Haverstraw. There are four yards here. They obtain their clay from one large shallow excavation on the west side of the West Shore Railroad track and 500 feet north of Stony Point railroad station. The clay has to be carted from 100 to 300 yards, and when the excavation is widened there is a stripping of three to six feet of sand and cobblestones. Corduroy roads have also to be used. The four yards are situated along the water front. One of them, Riley & Clark, uses stationary kilns. Riley & Rose have a covered yard, the other three firms dry their bricks on open yards. The clay bank is owned by T. Tompkins & Son.

The following are some tests of Haverstraw brick made by M. Abbott at the time the East River bridge was being completed. No packing was put between the brick and plate of testing machine.

| | | Crushing strength per square inch. Pounds. |
|---|---|---|
| Whole brick tested on end | Maximum | 3060 |
| | Minimum | 1600 |
| | Average | 2065 |
| Half brick tested on flat side | Maximum | 4153 |
| | Minimum | 2669 |
| | Average | 3371 |
| Half brick tested on edge | Maximum | 6400 |
| | Minimum | 2900 |
| | Average | 4612 |

Had the surfaces been ground parallel and cardboard or blotting paper been put between the face of the brick and plate of machine, higher results would have no doubt been obtained.

*Thiells*, Rockland Co. About two miles south from Haverstraw and half way between the stations of Ivy Leaf and Thiells, on the New York and New Jersey Railroad, is the brick yard of Felter & Mather. The clay deposit is basin-shaped, about 15 feet thick, as determined by boring, and has a slightly elliptical outline The clay is chiefly of a blue color, the upper portion being weathered to yellow. It is overlain by a few feet of drift containing small bowlders and underlain by similar material. The tempering sand is obtained from a bank on the opposite side

of the railroad track about 1000 feet from the yard. Tempering is done in ring pits; the bricks are molded in soft mud machines and dried on an open yard. Burning is done in scove kilns. The product is shipped to various towns along the line of the railroad in New Jersey.

*Cold Spring*, Putnam Co. A brick yard was in operation north of this town for a number of years, but has been shut down on account of the clay giving out.

*Storm King*, Dutchess Co. About 1000 feet north of the station is a clay deposit, chiefly yellow clay. It is worked by Mosher Bros. The bank has slid considerably; it has a vertical height of 50 to 60 feet.

*Cornwall on Hudson*, Orange Co. C. A. & A. P. Hedges are the only brick manufacturers here. Their yard is situated on the West Shore Railroad about a mile north of Cornwall station. They have 27 acres of clay land. Blue and yellow clay are found in the bank, the main portion of which is covered by delta deposits of Moodna River. The clay layers are much compressed in places, making it difficult to excavate and necessitating the use of picks. The bank is worked in benches and the clay has to be hauled about 300 feet to the machines. The stripped sand can be used for tempering. Many bricks are shipped to points on the New York, Ontario and Western Railroad.

*New Windsor*, Orange Co. There are six yards here. They obtain their clay from the escarpment of a terrace 110 feet high. Their clay is both blue and yellow. Streaks of quicksand occur in the blue. The yellow is dry and tough, and has to be worked by undermining. In thickness the clay varies from 20 to 60 feet; the layers are in many places contorted, and in some cases the stratification has been obliterated. Overlying the clay is gravel and sand; the latter is used for tempering. Most of the New Windsor clay permits the addition of very little water in tempering. Ring pits and Adam machines are used at these yards. The yards are all situated along the river and ship their product on barges or by the West Shore Railroad.

*Dutchess Junction*, Dutchess Co. There are several brick manufacturing firms having yards along the river south of Dutchess Junction (*see* table No. 1). They obtain their clay from the escarp-

ment of an 80-foot terrace which extends from a short distance north of Storm King to Dutchess Junction. The clay has a fairly uniform thickness; the upper four to eight feet are yellow, the rest blue. The greatest thickness of clay known for this locality is at Aldridge Bros.' yard, where a well was sunk 65 feet through the clay, which added to the height of the bank (65 feet), gives us a total thickness of 130 feet at this point. The clay is usually covered by gravel, and by sand in some cases sufficiently fine to be used for tempering or even molding. It is worked in benches, and the haulage distance is 200 to 300 feet. At Timoney's clay bank there is some extra labor in stripping the scrub oaks and other bushes which cover the surface of the terrace.

*Fishkill*, Dutchess Co. Harris & Ginley's yard is situated about one quarter mile below the town The clay bank is leased from the New England Railroad Company. It was formerly quite thick, but clay having been dug for 50 years but a small portion of the bank remains. The clay has a maximum thickness of 45 feet. Streaks of quicksand occur throughout the clay; it is underlain by hardpan and shale.

The other yards at this locality are situated along the river from a point about one half mile above Fishkill up to Low Point station. One of the yards is just north of Low Point. The most southern one is that of Aldridge & Sherman, with 600 feet water front. The clay land of these two firms belongs to the W. E. Verplank estate. Next on the north are the works of the Brockway Brick Co., with 1200 feet of water front. This firm owns its clay bank. The bricks are dried on pallets. The next two yards belonging to Lahey Bros., (650 feet water front) and Dinan & Butler (475 feet water front), respectively, lease their clay bank from the W. E. Verplank estate. Dinan & Butler have a pallet yard. The five above-named firms obtain their clay just east of the yards from the escarpment of a 90-foot terrace; it is both blue and yellow and overlain by four to six feet of loam, sand and gravel. A short distance north of Dinan & Butler's yard is that of J. V. Meade. About 20 feet of clay are exposed in the bank, which adjoins the yard. The clay is overlain by four to six feet of sand and cobblestones. The sand is screened and used for tempering.

C. G. Griggs & Co.'s brick yard is located along the river about one half mile north of Low Point station. An opening has been made for clay about 800 feet east of the yard; the clay as exposed at present is 20 feet thick and overlain by two feet of loam. One hundred feet farther east, and at a slightly higher level, sand for tempering has been dug to a depth of eight feet without finding clay. The clay is hauled in carts to the yard.

*Roseton*, Orange Co. There is a remnant of a terrace at this locality 120 feet high. From this J. J. Jova and Rose & Co. obtain their clay. The former has 80 acres, the latter 40. The clay is mostly blue and rises to a height of 100 feet above the river. At Jova's upper yard it is underlain by limestone and overlain by sand. On top of the clay at his lower yard are 10 to 15 feet of sand and gravel.

A well was sunk from river level at Jova's and passed through the following:

| | |
|---|---|
| Blue clay.. .. ..... ..... | 80 feet. |
| Quicksand..... | 25 " |
| Loose sand and gravel ..... | 75 " |
| | 180 feet. |

Adding to the above section 100 feet of clay above river level gives us a total thickness of 180 feet of clay. At Rose & Co.'s yard, which adjoins Jova's on the south, a well was sunk 135 feet through blue clay, it is claimed. Adding to this 108 feet of clay above mean tide gives us a bed of clay 243 feet thick. The terrace which the clay underlies at Roseton extends back from the river several hundred feet into a reëntrant angle of the hill. The clay contains little sand and is worked in benches. Carts are used to haul the clay. South of Roseton station is a bank of sand of alternating yellow and grayish black layers, which has been used for tempering, but is said not to give as good results as that on Jover's premises.

*Port Ewen*, Ulster Co. S. D. Coykendall's yard lies near the junction of Rondout Creek and Hudson River. The bank is

just west of the yard. There is a considerable stripping of fine sand and the clay slides quite easily. It is dug at any convenient point of the bank. The overlying sand can be used for tempering and molding. Oil is used for burning the bricks. A short distance farther south along the river is J. Kline's yard. He obtains his clay from various points in the terrace escarpment and in some cases hauls it nearly a quarter mile. Mr Kline has made borings at various points along the river and the terrace and in the escarpment in the vicinity of his yard and claims that at none of them has he found over 18 feet of clay. Beneath it was hardpan. This would seem to indicate that the central mass of the embankment is rock, overlain by hardpan, and that on this the clay is laid down. In many places the clay is covered by 10 to 20 feet of fine stratified sand.

The following is an analysis of the blue clay near Rondout which is used for the manufacture of cement:

| | |
|---|---|
| Silica | 57.8 |
| Peroxide of iron and alumina | 22.6 |
| Lime | 4.85 |
| Magnesia | 2.07 |
| Water and alkalies | 12.68 |
| | 100.00 |

*East Kingston*, Ulster Co. There are eight brick manufacturing firms at this locality, viz.: Streeter & Hendrix, D. S. Manchester, Brigham Bros., C. A. Schultz, A. S. Staples, R. Maine & Co., Terry Bros. and W. Hutton. They all obtain their clay from the terrace escarpment which extends from Glasco to Rondout. (For thickness of clay see table.) At Street & Hendrix's yard the clay lies some 300 yards from the river. They obtain their tempering sand from Wilbur. Manchester's bank is similar. At Brigham Bros.' yard the clay is yellow, being weathered clear through to its base. It has a thickness of 10 feet and rests on an uneven ridge of shale. On account of its toughness it is worked by undermining, as is the case with other yards along here where clay is being dug. C. A. Schultz has an exposure of clay 80 feet thick, overlaid in spots by sand that can be used for tempering. Next on the south is A. S. Staples' yard. The bank has been

excavated to a lower level than the preceding one. The clay is underlain by hardpan. R. Maine & Co. have five acres of clay land. The terrace here is quite narrow. At Terry Bros'. yard the clay, which is mostly blue, has been excavated sufficiently to expose the limestone against which the terrace lies. At Hutton's yard the blue clay is exposed from eight feet above mean tide, to 110 feet above it; overlying this is 10 feet of yellow clay and then 15 feet of sand. It will be seen from the limits quoted above and in the table, that the thickness of the clay between Glasco and Rondout varies considerably, amounting to 120 feet in places, while in others it is not over 15 or 20 feet. This is due to the great irregularity of the underlying rock surface.

*Smith's Dock*, Ulster Co. The only yard here is that of Theo. Brousseau. He has about 90 acres of clay land. The clay, which is mined with plow and scrapers, is obtained from the terrace east of the yard. It is mostly blue and covered by a few feet of loam. The yard lies some 700 feet from the river and the bricks are carted down to the dock. Brousseau's property extends west to the West Shore Railroad and the farms north and south of him are underlain by clay.

*Malden*, Ulster Co. The clay at Cooney & Farrell's yard to the north of the village is mostly yellow, and lies 10 to 20 feet thick on the upturned edges of the Hudson River shales. This yard was started in 1891.

*Glasco*, Ulster Co. Washburn Bros. This firm is one of the largest producers along the river having a yearly capacity of 50,000,000. They have about 150 acres of land, a large part of it being situated along the river. Their clay is mostly blue and rises in a bank to the height of 130 feet. It has been excavated to eight feet above mean tide. The upper 10 feet is yellow sand; a thin strip of yellow clay separates it from the red. The lower third of the bank is somewhat sandy, and the best results are obtained by a mixture of the upper and lower portions of the clay. Both pallets and open yards are used for drying; the former at the yard situated on the terrace. A short distance below Washburn Bros. is F. M. Van Dusen's yard. The clay is blue 70 feet thick and is underlain by shale whose surface is glaciated. Several feet of loam overlie the clay. Tempering sand is brought from Wilbur on Rondout creek. J. Porter's yard

adjoins Van Dusen on the south. The clay lies on a ridge of shale which rises steeply from the shore to a height of 60 feet. The brick yard is at the foot of the cliff and was started in 1891. Plows and scrapers are used to mine the clay which is of a yellow color, and overlaid by three feet of loam. Carts are used for hauling the clay. About a mile below this are the yards of C. H. Littlefield, A. Rose & Co. and D. C. Overbaugh. The three are close together. A ridge of shale rises steeply from the river and behind this the clay lies. The terrace here is 150 feet high, and borings which have been made show a depth of as much as 60 feet (see table). The clay is quite dry, and mostly yellow. It is worked by picks and undermining. Carts haul it to the edge of the cliff, where it is sent down shutes to the tempering pits. The drying is done on pallets at Rose's yard.

*Arlington*, Dutchess Co. Flagler & Allen. The clay deposit which is yellow is situated a half mile east of Poughkeepsie and has an extent of about 40 acres of clay, it averages from six to eight feet in depth. This is easily worked, there being only a stripping of six inches of sod. Underneath the yellow is considerable blue clay, of which the yellow is of course the weathered portion. The clay is tempered in soak pits and about 20,000 brick are made daily. The machinery is run by horse power. Repressed brick are also made. The clay burns a cherry red.

H. R. Rose's brickyard is also situated at this town and about three miles east of the Hudson river. The clay deposit, which has an extent of 60 acres, is yellow in color and eight feet thick. A blue clay is said to underlie the yellow. The bricks are molded in soft mud machines operated by horse power.

*Barrytown*, Dutchess Co. There are deposits of clay along the river at this locality but they are not being worked. The following is an analysis of them:

| | |
|---|---|
| Silica | 59.81 |
| Peroxide of iron and alumina | 22.00 |
| Lime | 4.35 |
| Magnesia | 2.29 |
| Moisture | .37 |
| Combined water and organic matter | 7.89 |
| Alkalies, not determined | ..... |
| | 96.71 |

*Catskill*, Greene Co. Alexander McLean's yard is situated on Water St. east of the wagon bridge. He has 12 acres of clay land. The clay is mostly blue with yellow and red on top, and is about 90 feet thick.

A partial analysis of the blue clay is as follows:

| | |
|---|---|
| Silica | 50.60 |
| Alumina | 21.00 |
| Peroxide of iron | 7.35 |
| Lime | 3.75 |
| Magnesia | .96 |

The upper portion of the clay bank is a tough material and has to be worked with a pick. A gray black sand of the same structure and appearance as that at Coeymans underlies the clay. At this locality it contains too much lime, however, to use it for tempering. Mr. McLean has to bring his tempering sand from Jones' Point at the cost of 40 cents a cubic yard. The manufacture of drain tile, hollow brick and sewer pipe has been attempted with this clay, but was given up it is said for financial reasons. Ferier & Golden's yard is situated on the opposite side of the street from McLean's, and their clay bank is practically a continuation of his. Their tempering sand is carted from near the West Shore Railroad station, a distance of about three quarters of a mile. The bricks are burnt with wood, though petroleum was used for a while successfully, it is claimed. The bricks are run down to the dock on cars. Lying along the creek north of the bridge is the Derbyshire Brick Co.'s yard. Most of the drying is done under sheds. The clay is both blue and yellow and is dug in a rather steep face causing it to slide often. The blue has been excavated to 38 feet from tide level, and its upper limit is 82 feet above tide; over this is 12 feet of yellow clay and three feet of loam. The tempering sand is obtained about half a mile from the works As at the preceding yard the bricks are loaded on cars at the kiln and run down to the dock.

*Hudson*, Columbia Co. There are three yards at this town. J. Fitzgerald's Sons' yard is situated in a reëntrant curve of the shore, and about 300 yards east of it is the yard of Arkison Bros. The former is no longer in operation. Both these firms obtain their clay from different faces of the same hill. The clay, which

is fairly dry, is mined with plows and scrapers. It is blue and yellow, from 70 to 80 feet thick, overlaid by two feet of loam, and underlain by grayish black sand.

W. E. Bartlett's brick yard is also situated along the shore, about one quarter mile north of Hudson. The clay is similar to that farther down at Fitzgerald's. Scrubby pines cover the surface at this locality. The bank is worked in benches. Ring pits are used for tempering.

*Stuyvesant*, Columbia Co. Walsh Bros. have two yards situated along the river midway between Stuyvesant and Coxsackie. All the clay thus far mined is yellow in color, very tough and unstratified. It is worked by picks and carted down to the yards. The bank which is 30 feet in height is located on the hillside some 500 feet east of the yard. It is probably underlain by the sand and gravel which crops out in the terrace escarpment behind the yard, and which is used for tempering.

*Coxsackie*, Greene Co. There is only one yard here, that of F. W. Noble. It is situated at an elevation of 100 feet above the river, and about a quarter mile north of the village. The clay bank adjoins the yard and is 35 feet high. Both blue and yellow clay are used. Shale underlies it. The clay is quite dry and is broken up by undermining. Soak pits are used for tempering. There is an exposure of blue clay in the terrace escarpment south of Coxsackie.

*Athens*, Greene Co. Of the three yards at this locality, situated about half a mile north of the village and adjoining each other, only two are running. The most southern one is that of William Ryder, situated 80 feet above tide level and about 500 feet from the river. Mr. Ryder owns 12 acres of clay land. The clay which has not been excavated below the level of the yard runs up to 125 feet above mean tide, and is both blue and yellow with about six feet of loam covering. A well was sunk 18 feet below the level of the yard, without reaching bottom. The clay is mined by plows and scrapers. The upper six feet of loam are mixed with the clay. The bricks when taken from the kilns are sent on cars down to the shore, where they are loaded on barges for shipment to New York City. Adjoining this yard on the north is that of Mr. Porter, not being worked. A few hundred feet north of this, on the south side of Murder Creek, is the yard

of I. R. Porter. Although the yard is situated near the shore the water is not deep enough for the brick barges, and the bricks have to be carted some 200 yards to the dock. The clay bank adjoins the yard and is mined by plows and scrapers. Horse-power machines are used.

*Coeymans Landing*, Albany Co. There are two brick yards at this town; they lie north of the town along the river shore and adjoin each other. The one nearest town belongs to Sutton & Suderly, and is worked by them and four other parties. Their clay is obtained from the bank west of the yard. It is both blue and yellow, chiefly the former, with streaks of fine sand.

The following partial analysis has been made of Sutton & Suderly's clay:

| | |
|---|---|
| Silica | 51.10 |
| Alumina | 17.65 |
| Peroxide of iron | 6.47 |
| Lime | 7.45 |
| Magnesia | .87 |

Being of a soft nature the clay is dug with shovels at any convenient point at the base of the bank, which is 120 feet in height. A charge of dynamite is usually exploded in the bank in the spring, thus bringing down a large mass of clay to a level with the yard. The clay does not have to be hauled more than 150 feet to the machines. A drive-pipe well sunk near the owners' barn on top of the terrace (140 feet above mean tide) some 300 feet back from the river, showed 70 feet of clay and 60 feet of sand. The sand underlying the clay is of a grayish black color, consisting chiefly of grains of quartz and shale, the latter predominating.* Grains of garnet and feldspar, and large pebbles of quartz are scattered through it. The sand after being screened is used for tempering. The upper limit of the underlying sand varies, at the north end of the property rising to within a few feet of the terrace level, while some 300 feet south of this the clay has been excavated to 15 feet above mean tide without striking sand.

Adjoining Sutton & Suderly on the north is the brick works of Corwin & Cullough, sublet by them to T. Finnegan and Delaney

* This underlying material is much faulted owing to the pressure of the clay above it.

& Lavender. The clay, which is obtained just west of the yard has been excavated to seven feet above mean tide and bottom not yet reached. It contains several veins of fine sand. Both yellow and blue clay are present. At the south end of the yard the escarpment of the terrace is drift containing small bowlders. The tempering sand is obtained from this bank.

There are outcrops of clay on the land of Mr. Bronk, to the north of Corwin & Cullough's yard; also on the Lawson property to east of the white iron bridge crossing Coeymans Creek. This latter locality lies some 800 feet from the river, and would be somewhat more expensive to work. Again, on Main st., just south of the residence of Miss Wolf, there is an exposure of clay on the hillside some 400 feet from the river.

*Albany*, Albany Co. There are several yards situated on the outskirts of the city. The clay banks, which are all of the same nature, belong to the Hudson River estuary formation, being stratified and blue or gray in color with the upper portions weathered yellow or red. M. H. Bender's yard is on Delaware avenue near Dove St. He manufactures common pressed brick and drain tile. The upper loamy clay can only be used for common brick; the lower blue and some of the yellow are used for the other products. Auger machines are used for better grade brick and the tile, and the latter are made in several sizes. Scove kilns are used for burning the brick and down-draft kilns for the tile. These latter kilns hold 60,000 small size tiles or 35,000 assorted size. It takes three wheelers and two setters two and a half days to fill the kiln and burning occupies four days. The tiles after molding are first dried on shelves under a closed shed.

Adjoining Bender's yard are those of J. Babcock, E. Smith, J. C. Moore and D. H. Stanwix. They make common brick chiefly, and their clay banks are the same as Bender's. They are all open yards.

T. McCarthy's yard is situated on First Avenue. The clay bank is about 15 feet thick and covers an area of about 10 acres. It is chiefly blue. The stripping is a light soil and sand underlies the clay. The bricks are manufactured by the soft mud process.

Alfred Hunter's yard is situated on Van Woert street near Pearl. The clay is blue with yellow on top. About 40 feet of clay is at present exposed. There are only a few inches of soil to be stripped. The bottom has not yet been reached. Ring pits and soft mud machines are used and the bricks are dried in the sun. Burning is done in scove kilns. Albany and vicinity consume most of the product.

The brick yard of M. Roberts is on Swan street between Ten-Broeck and Colonie. The clay is blue in color and about 25 feet thick. It is overlain by a loose soil; the bottom has not yet been reached. Soft mud machines operated by steam power are used; the bricks are dried on open yards and burned in scove kilns. Albany consumes the product.

*Greenbush*, Rensselaer Co. Mrs. T. Rigney's yard is at East Greenbush on the east side of the Boston and Albany railroad. The clay, which is blue and yellow, has a thickness of about 90 feet. Loam overlies the clay; the bottom has not yet been reached. The machinery is run by horse power. Greenbush and New York city are the chief markets for the product.

*Troy*, Rensselaer Co. Alex. Ferguson's brick yard is situated on Hoosick above First street. The clay bank is about 40 feet high and runs in an east and west direction; it is deeply incised at either end by two streams. The clay, as is common to these Hudson estuary deposits, is stratified, yellow in the upper portion and blue clay in the lower. The blue contains some quicksand. A stronger and better colored brick is made from the tough upper clay, but it shrinks considerably in burning. On the other hand the blue clay makes a smoother but not as strong brick, but one of more even shape. Underlying the clay is slate rock which has been used for building purposes.

J. B. Roberts' bank is about 20 feet in thickness. The clay, which is mostly yellow, is covered with a foot of loam and underlain by gravel. Capacity, two million.

*Cohoes*, Albany Co. J. E. Murray. Yard situated between Crescent and Cohoes, on west side of Erie canal. The clay is chiefly blue, the upper few feet being yellow. It rises in a bank to 50 feet height. It is underlain by rock and there is a slight covering of loam. The bricks are molded by steam power

machines, and dried in the sun. The product is sold in Cohoes and vicinity. J. E. Murray also operates the brick yard formerly belonging to N. Gardonas.

J. Baeby. The clay bank is about 40 feet high, 400 feet long and about 250 feet from the yard. Mr. Baeby has about 40 acres of clay land. The clay is yellow on top and blue beneath. It is covered by about four inches soil and underlain by gravel. One yard is operated by horse, the other by steam power.

*Lansingburgh*, Rensselaer Co. T. F. Morissey has a horse-power yard situated along the Old Turnpike near the railroad. The clay bank is 75 feet high, there being about six acres of clay land. The upper third of the bank is red, the lower two thirds blue. About 30 feet of sand underlie the clay.

*Crescent*, Saratoga Co. Newton Bros. have a bank of clay 30 feet thick, the upper six feet being gray, the rest blue. There is a stripping of two to four feet of sand, which can be used for tempering. The blue and yellow clay, together with a certain portion of sand, are tempered in the pug mill. The bricks are molded on a Martin soft mud machine and dried on pallets for about five days. Burning is done in scove kilns and the product is loaded onto the Erie canal boats at the yard.

*Mechanicsville* Brick Co., Saratoga Co. The brick yard is situated on the Champlain Canal in the town of Half Moon, about a mile south of Mechanicsville. The clay bank is 50 feet high. The upper 10 feet are yellow and under this is blue clay; the latter is underlain by sand. The bank adjoins the yard and is worked in benches; the clay is hauled in carts to the ring pits. Soft mud machines are used, the brick are dried on pallets and burned in clamps.

*Saratoga*, C. L. Williams. The yard is situated about one mile from the town, 600 feet from the Delaware and Hudson Railroad. Mr Williams has about 50 acres of clay land, the clay running six feet thick. It is blue, with the upper portion of it weathered to yellow. There is a stripping of about one foot of loam. The clay is put through a crusher first; it is then pugged and molded. The bricks are dried on pallets, the racks having a capacity of 260,000. Wood is used for burning, being obtained from a lot of 200 acres near the yard. The product is chiefly used locally.

The other brick yard at Saratoga is owned by Mr. D. Davidson. It is situated at the outskirts of the town, just west of Judge Hilton's yard. The clay bank, which is about 28 feet thick, is about 150 feet from the yard; it is stratified, the layers being from one to eight inches thick and separated by thin laminæ of sand. The clay is of a light brown color, being underlain by calciferous limestone and overlain by a foot of soil. Mr. Davidson has 22 acres of clay land. Tempering is done in ring pits and the clay is molded in a soft mud machine. Drying is done in an open yard, and burning in scove kilns. The fuel used is hard wood.

*Hoosick Falls*, Rensselaer Co. John Dolin's clay bank is about 40 feet high and has an extent of six acres. It is used for making building brick. The product is consumed in the vicinity.

*Middle Granville*, Washington Co. J. H. Pepper is the only manufacturer at this locality. His clay bank is 45 feet high, and 2000 feet long. The clay is blue, and scattered through it are some streaks of sand. A bed of gray sand 20 feet in thickness underlies the clay and is in turn underlain by slate.

*Plattsburg*, Clinton Co. There are several yards here. That of J. Ouimet lies at the north end of the town. It is an open yard and the bricks are made by hand power. The clay which is hard and tough is of a yellowish brown and red color and is mined with plows.

Charles Vaughn's yard is similar to the preceding, and is at the south end of the town. The clay is 20 feet thick.

Gilliland and Day's yard is situated on Indian Bay, six miles south of Plattsburg. The bricks are also molded by hand power.

All these yards sell most of their brick at Plattsburg.

The following is an analysis of the clay at J. Ouimet's brick yard:

| | |
|---|---|
| Silica | 65.14 |
| Alumina | 13.38 |
| Peroxide of iron | 7.65 |
| Lime | 2.18 |
| Magnesia | 2.36 |
| Alkalies | 8.51 |
| | 99.22 |

*Gouverneur*, St Lawrence Co. The brick yard of G. R. Thompson is situated east of village and on the eastern bank of the Osgewatchie river. The clay bank rises to a height of 10 feet above the river and the section exposed is:

| | |
|---|---|
| Sand | 4 feet |
| Gray clay | 8 " |
| Blue " | 6 " |
| | 18 " |

A Martin soft mud brick machine is used and the bricks are dried under sheds. The product finds a ready sale on the local market.

A pallet yard has recently been started at this locality.

*Carthage*, Jefferson Co. Wrape & Peck. The brick yard and clay pit are situated in the Black River Valley near the town of Carthage. The clay deposit which is several hundred acres in extent and about five feet thick is of a gray color with streaks of brown. The bricks are molded in wet mud machines and put in steam dryers. Local market consumes most of the product.

*Potsdam*. D. W. Finnimore's brick yard is situated a few rods outside of the village limits. The clay is of a blue color and six to eight feet deep. It is overlain by one to two feet of dark sandy soil and underlain by gravel. The yard is equipped with a Quaker soft mud machine, and a Kells & Son's dry press machine. The product is used locally.

*Watertown*, Jefferson Co. At the north end of the town on Main street are the works of the Watertown Pressed Brick Co. They have about 20 acres of clay, red in color, horizontally stratified and averaging about 20 feet in thickness. It is underlain by Trenton limestone. The tempering sand has to be carted nearly three miles. Analysis of the clay shows:

| | |
|---|---|
| Silica | 64.39 |
| Alumina | 4.40 |
| Peroxide of iron | 5.00 |
| Lime | 3.60 |
| Magnesia | 1.31 |
| Alkalies | 4.66 |
| Water and organic matter | 6.64 |
| | 100.00 |

The clay is rather tough. It is loaded on cars which are drawn by cable some 75 feet, up into the machine shed where it is dumped into a disintegrator. It next goes to the pug mill for tempering, and is molded in a Martin machine. Drying is done on pallets and burning in scove kilns, the latter occupying about seven days. The consumption is chiefly local.

*Ogdensburg*, St Lawrence Co. Paige Bros.' yard is on Cedar cor. Canton st. at southwest end of town. The clay is of a deep blue color, the upper 10 feet being somewhat sandy. It has been bored to a depth of 60 feet in places, but this depth is not constant, and in spots the underlying limestone rises to within a few feet of the surface. The sand for tempering has to be brought two miles. The following is an analysis of the clay:

| | |
|---|---|
| Silica | 49.20 |
| Alumina | 17.47 |
| Peroxide of iron | 6.23 |
| Lime | 7.86 |
| Magnesia | 4.87 |
| Alkalies | 9.82 |
| | 95.45 |

Only common brick are made. Soft mud machines are used. Drying is done in the sun and burning in scove kilns. The bricks have been largely used in the consumption of the asylum buildings at Ogdensburg.

*Madrid*, St Lawrence co. Three miles north of the depot is the brick yard of Robert Watson. The clay is of a blue color and about 20 feet thick. The section is

| | |
|---|---|
| Yellow sand | 3 feet |
| Blue clay | 20 " |

The bottom has not yet been struck. Horse power is used for operating the machinery. The clay has to be tempered with sand. Drying is done on pallets or in the sun. Burning takes about one week. The consumption is local.

*Raymondville*, St Lawrence Co. Coats Bros.' works are at Raymondville, about seven miles north of Norwood. The clay

bank lies on the east side of the Racket River. It is about 25 feet in thickness and there is a covering of 12 feet of fine sand. The clay is rather tough and requires an admixture about one-third sand for making brick. An abundance of unworked clay is still in sight.

*St Johnsville*, Montgomery Co. J. S. Smith is the only brick manufacturer in this town. The clay bank is 60 feet high, and the following is the section involved:

| | |
|---|---|
| Loam | 1 foot |
| Fine sand | 7 feet |
| Dark building sand | 3 " |
| Gray clay | 1 foot |
| Quicksand | 4 feet |
| Hardpan | 1 foot |
| Blue clay | 75 feet |
| Total thickness | 92 feet |

Only common brick are manufactured.

*Fonda*, Montgomery Co. W. Davenport's brick yard is about one mile west of the village on the north side of the N. Y. C. R. R. The clay bank lies to the north of the yard, is 12 feet high, and yellow in color. The brick are molded in soft mud machines operated by horse power, dried on open yards and burnt in scove kilns. The product is sold in Montgomery county. Drain tile are also manufactured.

*Dolgeville*, Herkimer Co. A. C. Kyser has a bed of clay about 50 acres in extent, and 30 feet thick. He manufactures ordinary building brick, which are consumed by the local market.

The clay is tempered in a pug mill with the addition of a certain amount of sand, and passes thence to a Quaker soft mud machine. Drying is done on an open yard, and the bricks are burned in a scove kiln. This latter operation takes five to eight days.

*South Trenton*, Oneida Co. H. L. Garrett has manufactured brick at this locality for 45 years. His clay bed is several acres in extent and about four feet thick. The clay is blue below and yellow and red in the upper portion of the bed, due to weathering. It is slightly stratified. Underlying the clay is slate.

*Amsterdam*, Montgomery Co. H. C. Grimes' brick yard is located on Florida Ave. The clay deposit underlies a tract of about 20 acres, and the section is as follows:

| | |
|---|---|
| Soil | 1–3 feet |
| Yellow clay | 6 " |
| Blue clay | ... . |

Common bricks are manufactured.

The clay is first passed through a Cotts disintegrator and is then molded on a soft mud machine. Drying is done on pallets. This yard has been in operation for 16 years.

*Gloversville*, Fulton Co. H. McDuffie's brick yard is situated on the outskirts of the town. The clay, which is of a dark brown color, is in a bed two and a half feet thick. It is underlain by hardpan and overlain by a thin soil. The bricks are made by the soft mud process, being molded in horse-power machines.

W. A. Stoutner. His clay bank is about three feet thick, underlain by hardpan and overlain by a few inches of soil. The clay is reddish brown and burns to a red color. The brick are made on a Peekskill hand-power machine. The brickmaking season at Gloversville runs from about the middle of May to the end of September.

*Ilion*, Herkimer Co. S. E. Coe. Brick yard situated along the Erie Canal, with the West Shore Railroad crossing the property. Mr. Coe has about 10 acres of clay land, the clay running in depth from eight to 15 feet. It is of three different colors, black, gray and blue. The latter makes the stronger brick. No stripping to be done except a few feet of black soil.

*Rome, N. Y.*, Oneida Co. W. Armstrong's yard is located on the edge of the town and along the Rome and Clinton branch of the New York, Ontario and Western Railroad. The clay deposit is about 25 acres in extent and the clay is of a dark gray color and seven to 10 feet deep. The bricks are molded in soft mud machines.

W. W. Parry. Yard located near the town; the clay is obtained from the flats bordering the Mohawk river, and the bed of it is from six to nine feet deep. It is underlain by gravel, which rises to near the surface in many places. A light loam covers the clay. For making brick the clay is mixed from top to bottom.

Both soft and stiff mud machines are used and burning is done in scove kilns.

*Deerfield*, Oneida Co. G. F. Weaver's Sons' yard is located on the Mohawk river about one quarter mile from the New York Central Railroad depot. Their clay deposit is about 40 acres in extent, and has been worked to a depth of 10 feet.

*South Bay.* C. Stephens has a brick and tile works at this town. The clay deposit is from 20 to 25 feet deep and underlies a tract of 800 acres bordering on Oneida Lake. Underlying the clay is a fine and closely cemented blue gravel. The Elmira, Cortland and Northern Railroad passes through the property. Chiefly drain tile are manufactured. These works were established in the spring of 1891.

*Canastota*, Madison Co. M. Ballou has a brick yard at this locality.

*Syracuse*, Onondaga Co. At the northeast end of the town is an extensive deposit of clay, underlying the low lands at the end of Onondaga Lake. It is worked by several brick manufacturers. The yards are mostly on Seventh North St. The first is that of T. Nolan, a horse-power yard; adjoining him is the yard of Preston Bros., also a horse-power yard. Next comes F. H. Kennedy, at whose yard the bricks are molded by hand. C. H. Merrick have a steam-power yard on S. Salina, and farther out on the Cicero plankroad are the brick works of J. Brophy.

The clay is stratified, red above and blue below. In the center of the flat land it runs seven to 10 feet deep, while at the edges it thins out to two feet. It is underlain by sand and gravel.

New York Paving Brick Co. This company has its works at Geddes near Syracuse and obtains its clay from a point called Three Rivers on the Syracuse and Oswego Railroad. The clay deposit is said to be 35 feet thick, and horizontally stratified. It is blue with the upper portions weathered to red. The brick factory is situated along the Erie Canal and the clay is brought by boat and stored in heaps, which in winter are covered to prevent freezing. Two Penfield soft mud machines with pug mills attached are used for molding. Drying is done in tunnels heated by coal fires. The green brick are nine inches long, but when burnt shrink to seven and one half inches. Both rectangular and cylindrical down-draft kilns are used. In addi-

tion to paving, a square tile, for linings, seven by seven inches and two inches thick is being manufactured. These, it is claimed, were placed for seven weeks in the acid vats at the Solvay works and were unaffected. The following tests were made on these bricks at the Watertown, Mass., arsenal:

| | Cracked at | Crushed at |
|---|---|---|
| | *Pounds.* | *Pounds per sq. in* |
| No. 1 | 91,000 | 29,060 |
| No. 2 | 93,400 | 28,530 |
| No. 3 | 119,000 | 20,060 |
| No. 4 | 167,000 | 23,500 |

The bricks are said to absorb on 1.49 per cent. moisture, which is very little.

*Warners*, Onondaga Co. The Onondaga Vitrified Pressed Brick Co This yard uses both shale and clay. The works are situated about half a mile east of Warners along the West Shore track.

Analyses of the shale have been made and are given below:

| COMPOSITION. | Calcareous layer in shale bank | A green brick. Being a mixture of the different shales. | Red Shale. | Blue Shale. | Clay. |
|---|---|---|---|---|---|
| Silica | 25.40 | 54.25 | 52.30 | 57.79 | 45.35 |
| Alumina | 9.46 | 16.89 | 18.85 | 16.15 | 12.19 |
| Peroxide of iron | 2.24 | 5.81 | 6.55 | 5.20 | 4.41 |
| Lime | 22.81 | 4.34 | 3.36 | 2.73 | 10.99 |
| Magnesia | 10.39 | 5.21 | 4.49 | 4.67 | 6.38 |
| Carbonic acid | 20.96 | 4.30 | 3.04 | 3.42 | 7.24 |
| Potash | .95 | 2.95 | 4.65 | 4.11 | 3.26 |
| Soda | ..... | .83 | 1.35 | 1.22 | 1.14 |
| Water and organ matter | 7.60 | 5.01 | 5.30 | 4.50 | 8.90 |
| Oxide of manganese | ..... | ..... | Trace. | Trace | ..... |
| Total | 99.81 | 99.59 | 99.88 | 99.79 | 99.86 |

Analyst, Dr H. Froehling, Richmond, Va.
The samples were all dried at 212° F.

It may be of interest in this connection to give the composition of some other clays found at Warners, and which are used in the manufacture of cement. The following are only partial analyse

| | | | | | | |
|---|---|---|---|---|---|---|
| Silica ..... | 45.12 | 43.19 | 46.00 | 41.78 | 41.70 | 44.00 |
| Oxide of iron and alumina ..... | 13.79 | 14.62 | 25.02 | 16.09 | 18.24 | 17.33 |
| Lime ..... | 12.91 | 12.36 | 7.13 | 12.40 | 12.71 | 11.74 |
| Magnesia..... | 7.21 | 7.05 | 3.67 | 5.83 | 6.02 | 6.83 |

These last analyses would indicate a rather fusible clay. The clay used by the Onondaga Co. is dug in the field adjoining the works. It is a pinkish color, stratified and runs about 15 feet in depth. The shale used belongs to the Salina formation and is obtained from the hillside about 1000 feet from the yard. It is of various shades of red, green and some gray, and disintegrates very rapidly. The whole mass is traversed by numerous seams so that a small blast brings down a large portion of the bank in small fragments. Tracks are laid from the brick yard up to the working face, the base of which is 35 feet higher than the yard. The loaded cars are run down to the dry pans by gravity and hauled back when emptied by a horse. Carts are used to haul the clay. Dry pans grind the shale and about one quarter clay and three quarters shale are mixed in a wet pan. A man shovels the mixture onto an endless belt which carries it to the molding machine. The yard is fitted with both a plunger and auger stiff mud machine, the former being side cut, the latter end cut. The green bricks are placed on cars and run into the drying tunnels. These are of brick, heated by coal fires, the heat passing through flues under the tunnel. Round kilns are used for the burning which takes about five days. The kilns have a capacity of about 60,000. Soft coal is used for burning.

The company manufactures paving brick, hollow brick and terra cotta lumber for fire proofing.

*Baldwinsville*, Onondaga Co. Seneca River Brick Co. The works are four miles west of Baldwinsville on the south bank of the Seneca River. Their clay bed is six acres in extent. It is

blue clay weathered to red in the upper portion and the blue is stratified. Gravel underlies the clay. The red clay is chiefly used as it burns a better colored brick than the blue. The dry press process is used and the bricks are burnt in kilns of the Flood type. These are both up and down draft. They are 18 by 54 feet and have 20 inch walls, which are lined with fire brick from the doors up. There are four fireplaces on each of the long sides and between these is a series of smaller ones connected with a set of flues opening into the lower part of the kiln to give an up draft. Wood fires are started in these smaller fireplaces for water smoking.. The larger openings connecting with individual pockets on the inner wall of the kiln lead the fire into the upper portions first whence it passes downward through the kiln and off through a large flue at the bottom. Water smoking takes 10 days and burning eight days. The whole time for burning, water smoking and cooling taking about three weeks. The molded bricks are set directly in the kiln on coming from the machine.

*Oswego Falls.* W. D. Edgarton. The brick yard is situated on the Syracuse and Oswego railroad, 11 miles from Oswego. The clay varies from three to five feet in thickness and is yellow. It is underlain by gravel. A few inches soil has to be stripped. The lower portions of the clay make the better brick. Soft mud machines are used and both common and repressed brick are made.

*Weedsport*, Cayuga Co. There is a brick yard at this locality belonging to Mrs. C. S. Gilette, but it is not in operation.

*Auburn*, Cayuga Co. John Harvey's brick yard is situated on the outskirts of the town.

*Owasco*, Cayuga Co. A. Lester has a brick and tile yard near the village. It is described under the head of drain tile.

*Seneca Falls*, Seneca Co. There is only one brick yard at this locality, that of F. Siegfried. His clay bed is about 12 feet thick, the upper seven feet being used for brick and the lower five feet for tile. Gravel underlies the clay and there is a covering of a few inches of soil. The machinery is run by horse power and the product is sold locally.

*Geneva*, Cayuga Co. Five firms manufacture brick in this locality. They are W. G. Dove, C. Bennett, Goodwin & Delamater, Mrs. Baldwin, The Torrey Park Land Co. The last-mentioned company began operations in the spring of 1892; their brick yard is some distance from the town.

*Lyons*, Wayne Co. The clay bed of F. Borck is about eight feet deep. The upper portion of the deposit is yellow, the rest is blue. Quicksand underlies the latter. Soft mud machines are used to mold the brick.

*Canandaigua*, Ontario Co. Burke & Mead's * works are about three quarters of a mile southwest of the station; their property adjoins the N. Y. C. R. R. track. The clay deposit, which covers several acres, is basin-shaped and has a known depth of at least 20 feet. It is of a blue color, weathered to red above, and on top of it is about a foot of peat. The clay after being dug in the fall is stored under shed until spring when it is molded by dry press machine. The brick are set directly in the kiln. Water smoking is done with wood and subsequent firing with oil. The blue clay burns buff and the other clay a red, so that by mixing the two a speckled brick is obtained. This firm has not been in operation very long.

The clay is quite siliceous, as the following analysis shows, and is similar in composition to the red terra cotta clay at Glens Falls. The composition is as follows :

| | |
|---|---|
| Silica | 62.23 |
| Alumina | 16.01 |
| Peroxide of iron | 6 96 |
| Lime | 1.24 |
| Magnesia | 2.21 |
| Alkalies | 5.08 |
| | 93.73 |

*Rochester*, Monroe Co. The Rochester Brick and Tile Manufacturing Co. is located on Monroe St. at the eastern end of the city. Adjoining this is the German Brick and Tile Co. The

* Since this report was written the firm name has been changed to "Empire Pressed Brick Co."

clay is reddish in color, four to five feet thick and underlain by hardpan. Lime pebbles occur in the lower portions. Molding sand is obtained from a neighboring esker.

The following is an analysis of this clay:

| | |
|---|---|
| Silica | 50.55 |
| Alumina | 15.46 |
| Peroxide of iron | 4.38 |
| Lime | 10.95 |
| Magnesia | 3.35 |
| Alkalies | 6.30 |
| | 90.99 |

*Maplewood*, Monroe Co. Robert Gay's yard lies along the N. Y. C. R. R. His clay is very similar to the preceding, but somewhat lighter colored. It is underlain by quicksand. This clay is used at Rochester to mix with Jersey fire clay in the manufacture of sewer pipe.

*Clarkson*, Monroe Co. M. Parker's brick plant is on northern side of the ridge road, at Clarkson, one mile north of Brockport. The clay is a shallow loamy deposit, and is owned by J. Sigler. The yard is an open one and both brick and drain tile are made. The molding sand is obtained from near the depot at Brockport. Product consumed locally.

*Albion*, Orleans Co. There is a small yard about a mile north of the town but nothing is known concerning it.

*Lockport.* The Lockport Brick Co.'s yard is at the northeast end of the town. The upper portion of the clay is being used. It is red in color, due to weathering. The clay is molded as taken from bank, the bricks are dried on pallets and burnt in scove kilns. Product used locally.

*La Salle*, Niagara Co. Tompkins & Smith run a small yard at this locality. Clay is very similar to that at Tonawanda. It is underlain by hardpan. Rolls are used to crush the lime pebbles in the clay before molding it. The product is marketed in the vicinity.

*Tonawanda*, Niagara Co. To the southeast of the town is the brick plant of Martin Riesterer. The clay is of a red color pass-

ing downward into blue and has a thickness of about five feet. Only common brick are manufactured, and the consumption is chiefly local. The burning is done with coal.

*Lancaster*, Erie Co. There are two yards here, the Buffalo Star Brick Co., near the Erie depot, and the Lancaster Brick Co. about two miles farther out. In the former's bank the clay is of a blue color below and weathered to red on top. Limestone pebbles are common in the clay, and for the purpose of separating them, the clay is stored in sheds to dry during the winter and passed through a barrel sieve before being used the following spring and summer. Plows are used to mine the clay, and coke and coal are used to burn the brick in stationary kilns with one fire per arch.

The bank of the Lancaster Brick Co. is similar to the one just mentioned showing:

8 feet red clay
1–2 feet blue clay
4 feet gray "
Rock

Limestone pebbles are also present and the clay after drying is screened. The bricks are burned in stationary kilns, coke being used for the water smoking and coal for the subsequent firing.

*Buffalo*, Erie Co. At East Buffalo is an extensive series of flats underlain by red clay which varies in depth from six to 20 feet. The following firms situated chiefly on Clinton St. use the clay for making brick: Chas. Berrick & Sons, Brush Bros., H. Dietschler & Son, F. Haake, L. Kirkover, Schusler & Co., G. W. Schmidt. Their combined production in 1892 was 65,000,000 brick. The clay is said to rest on the underlying rock.

The following is an analysis of it:

| | |
|---|---|
| Silica | 57.36 |
| Alumina | 16.20 |
| Peroxide of iron | 4.55 |
| Lime | 5.34 |
| Magnesia | 3.90 |
| Alkalies | 6.98 |
| | 94.33 |

Pebbles of limestone are scattered through it in places, and at a few spots several feet of yellow sand, suitable for molding or tempering, covers the clay. Below the limit of weathering the clay is blue and does not give as nice a colored brick as the red. The addition of tempering sand is not considered necessary. Soak pits and soft mud machines are used. All the yards dry their brick on pallets and burn them in stationary kilns, using coal fuel. One fire is made to burn one, two or three arches, according to the construction of the kiln. The burning takes nine days. Buffalo and its vicinity consume a large portion of the product.

Situated at the north end of Buffalo are the works of the Adams Brick & Terra Cotta Co. They have but recently commenced operations, and their chief product is brick and drain tile. The clay deposit is of the same general character as that of East Buffalo, having two to six feet of red clay on top, and below this blue, to a depth of 25 to 40 feet. Much of the blue can be used for coarser grades of pottery. A soft mud machine is used for common bricks, and a plunger stiff mud machine for tile and front brick.

They also have a dry press machine for making front brick. A. Steadman disintegrator is used in connection with this latter. The common brick are dried on pallets, the front brick in chambers. Burning is done in down-draft kilns and scove kilns. The latter are 40 by 15 feet, a smaller size than is customary. Five to six days is required for burning. This is a comparatively short period, and is partly due to size of kiln and partly to earthing. Parting sand from the iron foundry is used for molding.

*Jewettville*, Erie Co. Brush & Smith have recently started a brick yard at this locality. It is situated along the B. R. & P. R. R. track, about a quarter mile northwest of the station. The material used is Hamilton shale. It is of a grayish color and is easily worked. An opening has been made next to the yard and at the same level. A black, gritty shale crops out farther up on the hill, but this has not yet been used. The shale is loaded on cars and run into the machine shed, where it is

crushed in a dry pan and then molded in a dry clay machine; drying is done in tunnels and burning in stationary up-draft.

*Spring Brook*, Erie Co. There are extensive deposits of clay and shale at Spring Brook, on the land of E. B. Northrup, but they are not being worked.

*Evans*, Erie Co. Wm. Bolton has a horse-power yard here. The clay is a local deposit, chiefly blue in color, and the lower portions are stratified. It is underlain by sand and hardpan. The yard is run in accordance with the local demand for brick.

*Dnnkirk*, Chautauqua Co. Wm. Hilton's yard is situated in the valley, about one mile west of the town. The clay deposit is about 20 feet thick, and is underlain by rock. The upper six feet are yellow and below this is blue. Stones are found scattered through the clay and have to be separated. The yellow clay gives a better colored brick, while the blue clay shrinks more, but is said to give a harder product. The blue clay obtained from the main clay bank has to be tempered with sand; it has not been much used up to the present, however. Rolls are used to crush the stones and the clay is tempered in a pug mill. Mr. Hilton uses a soft mud machine of his own manufacture. The brick are dried on pallets, and the burning, which takes eight to 11 days, is done in scove kilns. Coke is used for watersmoking and coal for subsequent firing. Most of the brick are used in the vicinity.

*Jamestown*, Chautauqua Co. Two yards are in operation four miles east of this locality. Those of C. A. Morley and M. J. Mecusker & Son. They are about four miles east of Jamestown. The two yards adjoin each other, and the deposit of clay worked by them is of considerable size. In addition to brick, Mecusker & Son make drain tile and hollow brick. The clay deposit is basin-shaped. A boring near the water works showed:

| | | |
|---|---|---|
| Yellow sand | 4 | feet |
| Quicksand | 6 | inches |
| Yellow clay | 5 | feet |
| Blue clay | 70 | " |
| Hard pan | ? | |

*Randolph*, Cattaraugus Co. J. Turner owns a brick clay deposit at this town, but has ceased working it.

*Hornellsville*, Steuben Co. The Hornellsville Brick & Tile Co. has its works at the north end of the town and have only been running one season. They use a Devonian shale for making brick, and have turned their attention thus far to paving brick. The shale is mined about a mile from the works. It contains several thin layers of sandstone which can not be used. The process as followed here consists of grinding the shale in a dry pan, molding in stiff mud side cut machine and then re-pressing. Drying takes about 24 hours, and is done in chambers heated by a hot blast. Burning is done in down-draft cupola kilns and takes seven to 10 days. The paving brick are in extensive use in Elmira.

An analysis of this clay made by C. Richardson in the office of the engineering commissioners, at Washington, showed:

| | |
|---|---|
| Silica | 64.45 |
| Alumina | 17.77 |
| Peroxide of iron | 7.04 |
| Lime | .58 |
| Magnesia | 1.85 |
| Potash | 2.52 |
| Soda | 1.95 |
| Insol. in acid | 88.74 |

W. H. Signor owns the other yard at Hornellsville. His clay bank is owned by M. Adsit. It is a shallow deposit, not over seven feet thick and underlain by quicksand, this latter allowing the inflow of water from the neighboring stream. The bricks are molded by an auger machine, dried in the sun and burnt in scove kilns, the burning occupying about seven days.

*Alfred*, Steuben Co. Rock Cut Clay Co. This is another yard using a shale, which is in the same geological horizon as that at Hornellsville. The works are on the Erie R. R. a few hundred yards south of the station. They have but recently commenced operations. A dry clay brick is being made. A peculiarity in the dry clay process as practised here, is that the clay is molded a trifle damp, it being thought that this will preserve the corners

of the brick better. To dampen the ground clay it is discharged from the hopper into a long box of square cross section in which a worm screw revolves. The axis of the screw is hollow and has nipples which project into the tube three fourths inch so that if any of the steam which is injected to dampen the clay condenses it will not escape into the clay. The shale used is mined near the yard and hauled in carts to the dry pan.

*Big Flats*, Chemung Co. Near the village is an extensive bed of clay owned by J. R. Lowe. It underlies an area of about 50 acres. Excavations have been carried to a depth of 15 feet without reaching the bottom of the deposit. The clay is of a bluish gray color. Mr. Lowe manufactures drain tile only and most of these are for private use.

*Horseheads*, Chemung Co. R. G. Eisenhardt has a clay deposit 100 acres in extent, and having an average thickness of about 20 feet. There is a covering of about 10 inches of soil. Underlying the clay is sand and gravel. Both the yard and clay bed are situated on a high terrace.

*Breesport*, Chemung Co. About one and a half miles south of the town are the yards of the Empire State Brick Co., Locy Bros. and P. M. C. Townsend. The bank from which they obtain their clay lies along the eastern side of the valley. It is about one half mile long and has a height of 50 feet. It is chiefly of a bluish color and is stratified in places.

We give herewith the analysis of the clay:

| | |
|---|---|
| Silica | 52.48 |
| Alumina | 16.78 |
| Peroxide of iron | 6.79 |
| Lime | 6.63 |
| Magnesia | 3.59 |
| Alkalies | 7.16 |
| | 93.43 |

At Locy's yard where borings show the clay to be 30 feet thick, a red clay also occurs. Yellow sand overlies the clay at several points and can be used for molding. The yards of Locy Bros. and Townsend are open ones. At the Empire State Co.'s yard tunnel driers are used, the clay being mixed in a wet pan and

then discharged through an opening in the floor of the latter on to an endless belt which carries it up to the molding machine. The brick are burnt in scove kilns.

*Spencer*, Tioga Co. W. H. Bostwick's yard is about one mile south of the village. The clay which is dug in a field adjoining the works, is a tough reddish material four to six feet thick. It is underlain by sand and gravel. The bricks are dried on pallets and burned in stationary up-draft kilns.

*Newfield*, Tompkins Co. F. C. Campbell's brick yard is about one mile north of the station along the Lehigh Valley Railroad. Adjoining the yard is the clay bank which rises to a height of about 50 feet. The clay is of a bluish color, the upper portions containing more sand.

An analysis of this clay showed

| | |
|---|---|
| Silica | 51.30 |
| Alumina | 12.21 |
| Peroxide of iron | 3.32 |
| Lime | 11.63 |
| Magnesia | 4.73 |
| Alkalies | 4.33 |
| Organic matter | 1.50 |
| | 89.02 |

Notwithstanding the high percentage of lime which gives the brick its cream color, a very strong product is produced. Covering the clay is several feet of yellowish stratified sand. Lime pebbles occur in the clay and a special apparatus is used to extract them. It consists of a large shallow circular pan in which a number of small wheels revolve on a shaft. The bottom of the pan is perforated. The clay is thus ground and passes through the bottom of the pan, while the stones are not crushed. The bricks are molded on stiff mud machines and repressed on a hand-power machine. Chamber dryers are used and burning done in down-draft kilns or scove kilns. The clay burns to a whitish brick; further burning at a higher heat gives a hard yellow brick, which is smaller, but sold for paving purposes. The following is a report of tests made on these brick in the laboratory at Cornell University: "All the bricks were tested on edge, as used for pur-

pose of paving. The sides were dressed to parallel planes on an emery wheel, so as to get uniform bearing over every part. Single layers of thick paper were placed between the brick and the machine.

| | No. 1. | No. 2. | No. 3. | No. 4. |
|---|---|---|---|---|
| Wt. of brk. in lbs..... | 4.86 | 5.14 | 5.1 | 5.00 |
| Dimensions ..... | $7\frac{3}{4}\times3\frac{5}{8}\times2\frac{3}{16}$ | $8\times3\frac{7}{8}\times2\frac{5}{16}$ | $8\times4\times2\frac{2}{19}$ | $7\frac{3}{4}\times3\frac{3}{4}\times2\frac{5}{16}$ |
| Cubical contents..... | 61.35 cu. in. | 70.7 | 74. | 67.20 |
| Area strained..... | 16.95 sq. in. | 18.5 | 18.5 | 17.92 |
| Height of column..... | $3\frac{5}{8}$ | $3\frac{7}{8}$ | 4. | $3\frac{3}{4}$ |
| *Total stress* | | | | |
| First crack..... | 208000 | 84000 | 56000 | 48000 |
| Splinters fly..... | 250000 | .... ... | 133000 | 108000 |
| Crushed ..... | 254000 | 172000 | 180000 | 141200 |
| *Stress per square inch* | | | | |
| First crack..... | 12230 | 4580 | 3508 | 2600 |
| Splinters fly..... | 14800 | ..... | 8362 | 6000 |
| Crushed ..... | 14990 | 9300 | 10909 | 7880 |
| Color of brick..... | Lt. cream | Lt. cream | Lt. cream | Lt. cream |
| | Homogen. columnar. | Black vitrified. | Homogeneous. | Homogeneous. |
| *Fracture* | | | | |
| Position of 1st fracture | One corner | Central .. | Central .. | At one end. |
| Direction of fracture .. | Vertical.. | Diagonal. | Vertical.. | Vertical. |
| Kind of brick ..... | Repressed | Common. | Common . | Common T. of soil. |
| Sp. gr..... | 2.18 | 2.01 | 1.91 | 2.07 |
| Wt. per cu. ft..... | 136.9 | 125.6 | 118.8 | 129.0 |

The repressed brick shows great strength; more than sandstone and four fifths that of granite. The best results of pressed brick usually show 6000 to 10,000 pounds per square inch.

*Homer*, Cortland Co. The brick yard at this locality belongs to Horace Hall of Cortlandt. His clay bed underlies the flat lands near the village of Homer, and is from three to five feet thick. Quicksand underlies the clay and overlying it is a dark soil two to six inches thick. The clay is of a bluish color.

*Binghamton*, Broome Co. There are two yards at this town, viz.: Wells & Brigham and the Ogden Brick Co. Their clay beds are similar, both being shallow deposits six to eight feet thick,

underlain by sand and gravel. The former of the two is a pallet yard, the other uses a tunnel dryer. Their product is consumed locally.

*Brookfield*, Madison Co. The Brookfield Brick Co. is the only firm manufacturing brick at this locality.

*Oneonta*, Otsego Co. Two firms are manufacturing brick at this locality, J. Denton & Son, and Crandall & Marble. The works of this latter firm is situated on the Albany and Susquehanna Railroad near the village of Oneonta. Two kinds of clay are used; one of them from a bank five to 20 feet in thickness, the other from a surface deposit three to five feet in depth. This latter bed is underlain by sand. The product is consumed by the local market.

*Goshen*, Orange Co. P. Hayne has a clay deposit 55 feet deep, underlain by black gravel. There is a slight stripping of sod. Both drain tile and brick are made from the clay.

*Florida*, Orange Co. W. H. Vernon's brick yard and clay deposit are situated in the valley near the town. The clay bed is 10 feet thick, blue in color and tough. The upper three feet are weathered to a red clay and make a better brick. The blue is of sufficient purity for making pottery. Underneath the clay is sand and hardpan.

*Oakland Valley*, Sullivan Co. Mr. O. B. Wheeler of Middletown, N. Y., has an extensive clay deposit here. There are about 125 acres of clay land lying between the Navesink River and the West Shore Railroad. The clay is found not only in the valley but is also exposed in numerous cuttings on the hillside. At the former spot a depth of 46 feet has been proven by boring and at the latter 17 feet. In many places the clay crops out; at others it is covered by one to three feet of loam. An analysis of the clay made by Prof. Draper of the New York City University shows:

| | |
|---|---|
| Silica | 37.50 |
| Peroxide of iron and alumina | 54.00 |
| Magnesia and lime | 3.50 |
| Moisture | 5.00 |
| | 100.00 |

It will be seen from the above that the clay runs high in iron, which would apparently make it fusible; however it is found to stand a high heat, according to a report made on it by Dr. N. L. Britton, of Columbia college. About one eighth sand had to be added to the clay for brick or tile ware. The sand, which is of a bright yellow color, is in banks along the Navesink River near the clay beds. This clay is also said to be available for paint. Oakland Valley is about 12 miles from Port Jervis.

*New Paltz*, Ulster Co. New Paltz Brick Co. Their brick yard is located on the outskirts of the town and near the Wallkill Valley Railroad, with which it is connected by a switch. The clay deposit is yellow, red and blue in color, and varies in depth from 15 to 50 feet. It underlies a tract of six acres. The separation of the clay in four to eight inch layers facilitates the digging of it. There is a thin stratum of overlying sand which has to be first stripped. Soft mud machines operated by horse power are used for molding.

*Warwick*, Orange Co. Although there are no brick yards in this vicinity, still extensive deposits of clay are undoubtedly present. A sample of clay from the Drowned Lands, lying along the Wallkill River in Orange Co., was analyzed in the laboratory of the N. J. Geol. Surv. with the following results:

| | |
|---|---|
| Silicic acid in combination | 28.9 |
| Quartz | 22.9 |
| Silicic acid free | 1.2 |
| Titanic acid | 0.5 |
| Oxide of alumina | 23.1 |
| Peroxide of iron | 7.2 |
| Lime | 0.7 |
| Magnesia | 2.6 |
| Potash | 4.1 |
| Water | 9.7 |
| | 100.9 |

The clay is said to exist in large quantity, forming a thick layer at this point in the alluvial district of the Drowned Lands, and underlying much of the black muck surface of this district.

The specimen sent was thoroughly air dried and was slate gray in color, and showed a little fine gritty sand. It contains too much oxide of iron and potash for any refractory or fine materials. Washing out the fine sand might enable it to be used in some styles of paper facing. It is most interesting as the basis of a valuable, enduring and fertile soil, and if properly drained it would be unsurpassed for tillage or pasturage; and as such it furnishes another argument for the drainage of this tract of drowned lands.

## Brick yards

*East Williston*, Queens Co. W. & J. Post have two yards at this locality. Their clay pit is in a field some 500 feet west of the yard on the land of H. M. Willis. The clay has been excavated to a depth of about 15 feet. It is chiefly a bluish clay and can be easily dug. The clay is extremely siliceous as the following analysis shows, but the percentage of lime, magnesia and iron is low:

| | |
|---|---|
| Silica | 69.73 |
| Alumina | 16.42 |
| Peroxide of iron | 2.58 |
| Lime | 1.66 |
| Magnesia | 0.69 |
| Alkalies | 6.27 |
| | 97.35 |

Carts are used to haul it to the yard. Pumps have to be used to keep out the water which comes up through the underlying sand. The clay is tempered without the addition of sand in ring pits run by horse power. The bricks are dried either on the open yard or on pallets and burnt in scove kilns with wood. They are shipped on the L. I. R. R., which passes by the yard.

*Oyster Bay*, Queens Co. An extensive deposit of clay is being worked on Center Island, in Oyster Bay, by Dunn, Dolan & Co. They manufacture common brick. The bank adjoins the yard, and the clay, which is in thin layers, separated by fine laminæ of sand, is of a bluish color in the lower portions of the deposit and

brownish above. The brown clay is more sandy, and there are six or eight feet of it. Over the brown is a less gritty and tougher clay, which runs nearly to the surface. The total height of the bank is about 25 feet, but the front is broken up into several wide benches. Springs issue from several sandy spots in the blue clay. In making the brick the different grades of clay are mixed together, and a certain proportion of sand, and also some coal dust added. Ring pits are used for tempering. The brick are dried on an open yard and burned in scove kilns. They settle eight to ten inches in burning.

*West Neck*, Suffolk Co. The clay at this locality rises in a bank to a height of over 100 feet. There are three yards but only two of them are active. Both are along the east shore of Cold Spring Harbor. The most southern one belongs to Dr. Jones. The clay in this bank is of a red and brown color, there being about 25 feet of the latter at the bottom and above it is the red which is of a more sandy nature. There is an upper covering of 15 or 20 feet of yellow gravel and sand, which after screening is used for tempering. This latter is done in ring pits. All the machinery is run by horse power. The bricks are dried on an open yard and burnt in scove kilns. The product is loaded on schooners and sent to New England and New York City. The lower brown clay has been used for coarser grades of pottery, and its composition is given below:

| | |
|---|---|
| Silica | 61.01 |
| Alumina | 19.23 |
| Peroxide of iron | 5.43 |
| Lime | 0.96 |
| Magnesia | 1.88 |
| Alkalies | 4.60 |
| | 93.11 |

Adjoining Jones' yard is that of Crossman Brothers. It is leased by Wm. Hammond. The clay in his bank is similar to that of Jones'. The yard is also an open one, steam power being used for running the machines and the tempering is done in rectangular pits.

*Fresh Pond*, Suffolk Co. This locality is about four miles east of Northport on the north shore of the island. There are two yards, about a mile apart. The most eastern one belongs to G. Longbottom. It is situated some 500 feet from the shore and about 50 feet above Long Island Sound. The clay bank is about 200 feet west of the yard and at the same level. A section in the summer of 1892 showed

| | |
|---|---|
| Sand and gravel | 4 feet |
| Red sandy clay | 8 " |
| Red clay | 6 " |

The overlying sand and gravel is stratified and dips east. It is screened for tempering. Carts are used for hauling the clay to the machines. Molding sand is obtained from Hackensack. The clay and sand are shoveled directly into a vertical pug mill, from which they pass to the molding machine. Coal dust is also added in tempering. The product is loaded on cars. run down to schooners at the dock and shipped to Connecticut. Adjoining Longbottom's yard is the inactiye plant of Provost.

About a mile west of Longbottom's and situated along the shore is the yard of R. Sammis. His land extends 2000 feet along the shore and the whole of that distance the clay crops out from underneath the sands and gravels. The lower portion of the clay is a bluish red, the upper, red in color and somewhat more gritty. The clay is rather tough but not so dry as Longbottom's. The carting is done along the shore, and the overlying sands which are highly stained with iron are used for tempering. A cutting has been made in the cliff just east of the yard for tempering sand. The bricks are burnt with wood.

*Greenport*, Suffolk Co. The works of the Long Island Brick Co. are some two miles west of Greenport on the shore of Pike's cove, opposite Shelter Island. Their clay is a glacial deposit of red color, rather tough and contains numerous stones. Mr. Sage, the owner, claims a depth of 64 feet for the deposit in places. Several openings have been made in it, one of them 24 feet deep. It is said to thin out to the east of the yard, where it is found to be underlain by hardpan. It is undermined, the working face being about eight feet high and

the clay is hauled to the machines in carts. It is tempered in soak pits, with the addition of one third its volume of sand. Hematite is also added in order to produce a good color in burning. The bricks are dried on pallets or on open yards. They are burnt in scove kilns, loaded on schooners and shipped largely to Connecticut. Many also go to points on Long Island.

*Southold*, Suffolk Co. Two miles east of the village is C. L. Sanford's yard. The clay is similar to Sage's. Mr. Sanford has about 29 acres of clay. It is worked chiefly by undermining, the working face being about 10 feet in height. In places gravel is scattered through it, but in others it is very free from stones. Borings have shown a depth of 65 feet of clay. The clay and coal dust are put into rectangular soak pits and from these are shoveled into the machine, the tempering sand not being added until then. The drying is done on pallets, whose total capacity is 154,000. Most of the product goes to Connecticut by schooner.

Below is given an analysis of the clay:

| | |
|---|---|
| Silica | 59.05 |
| Alumina | 22.11 |
| Peroxide of iron | 6.54 |
| Lime | 2.19 |
| Magnesia | 2.64 |
| Alkalies | 6.22 |
| | 98.75 |

*Fisher Island*, Suffolk Co. The extensive deposit of clay at this locality is worked by the Fisher Island Brick Manufacturing Co., whose plant has a capacity of about 15,000,000. The yards are situated on the north shore of the island between Clay Point and Hawk's Neck Point. About 1500 feet from the shore is the bank of clay, which is of a reddish color and thinly stratified, the layers of clay being separated by very thin ones of sand. In most places, however, the mass has been disturbed by glacial movements. There is a stripping of 20 or 30 feet of a whitish sand, the finer portions of which can be used for tempering. Their present working face is 30 feet above tide at its base, and the clay, it is claimed, has a depth of 40 feet at

least below this, as shown by borings. A sample from the upper half of the bank showed the following composition:

| | |
|---|---|
| Silica | 53.77 |
| Alumina | 20.49 |
| Peroxide of iron | 9.23 |
| Magnesia | 4.22 |
| Lime | 2.04 |
| Alkalies | 9 60 |
| | 99.35 |

The clay, which is said to improve with the depth, is worked by undermining. It is then loaded on carts and hauled about 200 feet to a platform, underneath which cars are run to receive the clay and sand. These cars in trains of three or four are drawn to the yard by four horses, the grade being slightly descending. Tempering is done in large rectangular soak pits, and open yards are used for drying the brick, or it is done on pallets. A small quantity of hematite is added to molding sand. The bricks are burnt in scove kilns with wood. Most of the product goes to Connecticut and Rhode Island.

*West Deer Park*, Suffolk co. About a quarter of a mile north of the station are the works of the Wyandance Brick and Terra Cotta Co. In appearance their clay bank is unique, for there is hardly another in this State which exhibits such a variety of colors. Two openings have been made for getting the clay. The main one shows a face about 12 feet high chiefly of black clay, the lower portion of this latter having thin layers of a grayish sand. Over the black is several feet of red and yellow clay. The other opening lies to the south of the first one, the clay being mottled, and shows various shades of red and yellow. Scattered through it are lenticular streaks of red and yellow sand. This second pit has a face about 20 feet high. In some places the stripping is 20 feet of sand and gravel, while in others it is not over three feet. A track is laid from clay shed to face of bank, the clay is loaded on cars and drawn by horses to the foot of an incline, up which it is drawn by cable into the clay shed and dumped.

A loam obtained near the yard is added to the clay to temper it and also to help in producing a brick of good red color. Hematite is also added to the clay while it is being pugged. The clay and loam are fed between a pair of rolls to crush any stones that may be present, and from these it passes to an inclined pug mill, where the water and hematite are added. The wet mixture goes through a second pair of rolls of smaller opening than the first, and is then carried by endless belt to the molding machine. A soft mud machine is used for molding the common brick, and for the front brick and hollow brick an auger machine is used. The molding sand is dried on brick floors 60 feet long, under which there is a series of flues, the heat being obtained from a coal fire at one end. Steam heated tunnels are used to dry the bricks. This takes about 36 hours. Exhaust fans are used to draw off the air. The burning, which takes seven to eight days, is done in Wingard and similar types of kilns, hard and soft coal being the fuel used Hollow brick are placed round the sides of the kiln, and front brick in a rectangular mass in the center. The black clay alone burns to a white brick. The product is shipped to points on the Long Island Railroad.

The light color of the brick made from the black clay is due to the absence of iron, and the black color of the clay is caused by the organic matter. The following is an analysis of it:

| | |
|---|---|
| Silica | 59.83 |
| Alumina | 24.45 |
| Oxide of iron | trace. |
| Lime | 0.23 |
| Magnesia | 0.59 |
| Alkalies | 8.75 |
| Organic matter | 4.28 |
| | 98.13 |

*Farmingdale*, Suffolk Co.— There is only one yard in operation at this town, that of M. Meyers. The inactive one belongs to Stewart. Meyers' yard lies about one mile north of the village, along the southern edge of the moraine, on a branch track of the railroad. The clay pit is some 300 feet from the yard, and several feet lower in level. The clay is chiefly a reddish yellow

and very plastic, but tough in places. The lower portions are quite free from sand. Mr. Meyers claims a thickness of at least 25 feet of clay in addition to the 10 feet exposed. At the entrance to the pit the clay is seen to be underlain by a bluish white micaceous sand, which is cross bedded and dips under the clay at a very steep angle. Hauling the clay is done in carts, and tempering in ring pits with the addition of sand and coal dust. Soft mud machines are used, and the drying is done on palettes. The pallet racks have sectional roofs which are hinged and can be lifted by a lever for the purpose of admitting more sunlight. The bricks are burnt with wood in clamps, and the product is shipped to various points on Long Island.

Below is given an analysis of the lower clay:

| | |
|---|---|
| Silica | 62.39 |
| Alumina | 23.60 |
| Oxide of iron | 3.39 |
| Lime | 0..0 |
| Magnesia | 0.10 |
| Alkalies | 5.89 |
| | 96.07 |

The low percentage of lime and magnesia would make this clay available for a higher grade of clay product, such as terra-cotta or pottery, but the high percentage of alkalies is somewhat objectionable.

*Staten Island* has two yards where common brick are manufactured. One of them belongs to McCabe Bros. at Green Ridge. Their deposit is a stony glacial clay of a red color, and lies to the northwest of the yard. Small boulders are scattered sparingly through it, and the upper portion is somewhat loamy. Borings have penetrated the clay to a depth of 25 feet and stratification appears with the depth. No sand or coal are added to the clay in tempering. It is first passed through rolls two feet in diameter, the one making 60 the other 600 revolutions a minute, and having an opening of half an inch. This partially breaks up the stones. The crushed material falls on a belt and is carried up to a pug mill where the water is added before it passes to the machine. Drying the bricks is done either in the sun or in tunnels. In the latter the bricks shrink more. The

tunnels are heated by coal fires. Wood is used for burning, and the kiln settles about four inches. The products go to New York city and the vicinity.

Wood & Keenan's yard is situated on the shore of Arthur's Kill, opposite Carteret. It is an open yard of greater capacity than its output. The clay is of the same character as McCabe's. It is tough and has to be worked with picks, and the pit is about 10 feet deep. Ring pits are used for tempering and the bricks are burnt with wood. New York city and Newark are the chief markets.

The New York Anderson Pressed Brick Co. has its works at Kreischerville adjoining Kreischer's fire brick factory. Various styles of ornamental and pressed brick are made. The company declined to give any information concerning its works. Their clay is obtained from a pit near Green Ridge. It is of a black and gray color. The pit is worked in benches, the clay being hoisted in buckets and loaded on cars which are run down to the works.

### Drain-tile

A clay that is capable of making good building brick will usually make a good drain-tile. That is to say, a plastic clay and one that will burn to a tough product. Contrary to bricks tile may be somewhat porous in their character. It is of importance that the clay should be thoroughly tempered before molding. This latter is in most instances done with some form of stiff mud machine, the clay being forced out through a die of desired pattern, and the cylinder of clay as it issues from the machine is cut up into desired lengths. Drying is sometimes done on pallets such as are used for common brick, or it may be performed under enclosed sheds. The drain-tile should be thoroughly dry before being set in the kiln. Burning is done in ordinary scove kilns, clamps or down draft kilns. The smaller tile are set in the lower portions of the kiln and around the sides, while the larger ones are set in the center. Very often when several sizes are burned at the same time they are nested, the smaller ones being set within the larger.

The styles of drain-tile made are as follows :

Horseshoe-tile, having cross section shape of a horseshoe.

Sole-tile, cylindrical with a flat base.

Pipe tile, plain cylinder.

Flange-tile, like preceding but with flange at one end.

It is considered by many that the best form of tile is the sole-tile with an egg shaped section having the smallest diameter across the bottom thereby keeping the water collected in the smallest possible space and securing a good current to carry off the sediment. The horseshoe-tile is objected to as it is liable to break from the lateral pressure of the soil. In Westchester county glazed sewer pipe are generally used for draining the soil, but it is doubtful if there is any special advantage in their use to warrant the use of this more expensive material. In sizes the tiles range from two to 12 inches in diameter and one to two feet in length. They are laid at varying distances below the surface according to depth the ground is to be drained. A drain is said to draw water from the soil on either side for a distance of from 30 to 100 feet, according to depth of drain and character of soil.

The following firms in this State are making drain tile:

*Albany*, Albany Co. The New York State Drain-tile Works are large producers. The drain-tile are made in numerous sizes. Hudson river clay is used. Front brick are manufactured.

*Chittenango*, Madison Co. Central N. Y. Drain Tile and Brick Co. Only tile manufactured at present. The plant is located about one mile from the N. Y. C. R. R. and three-quarters of a mile from the W. S. R. R., and a few rods south of the Erie canal. The clay bed lies at the foot of the hill. There is no stripping, and sand underlies the clay. The tiles are made with horse power machinery, dried under sheds and burned in down draft kilns.

*Allen's Hill*, Ontario Co. B. G. Abbey's are the only works here. Few brick have been manufactured for several years, as drain-tile are the chief production. After stripping a few inches of soil the clay is mixed from top to bottom of the bank for use. The bank is 20 to 25 feet in height, and the clay is blue in color, becoming reddish gray near the surface. A small amount of coal dust is added to the clay. The tiles are made in various sizes.

*East Bethany*, Genesee Co. B. F. Peck manufactures brick and drain-tile. The clay deposit worked is a portion of a strip one to

two miles in width and extending east and west across Genesee Co., a few miles north of its southern boundary. The clay is usually covered with a thin layer of clayey loam. Mr. Peck has about 50 acres of clay of sufficient quality for making bricks and tile. It averages about four feet in thickness. The upper portion when dry is nearly white, but becomes blue with the depth, and below four feet is very much so. It is also tough, coming up in hard flakes of a stony nature. Below this it passes into the shale, hard enough to resist the pick but crumbling on exposure. This last mentioned rock is said to contain calcareous layers, varying in thickness from one to six inches. About 250,000 feet of drain-tile are annually made for local use. The clay burns to a nice red in the drain-tile, deepening to brown when burned harder. The machinery is run by steam power.

*Owasco*, Cayuga Co. A. Lester's clay bank and brick yard are located in the north end of Owasco village on the bank of Owasco Creek. The clay deposit has an area of about nine acres and is from 10 to 15 feet in thickness. Gravel overlies the clay in places. Soak pits are used for tempering, and a Penfield plunger machine for molding. The tiles are dried in an open shed and burnt in scove kilns. Drain-tile is the chief production but a few bricks are made. The color of the product is white.

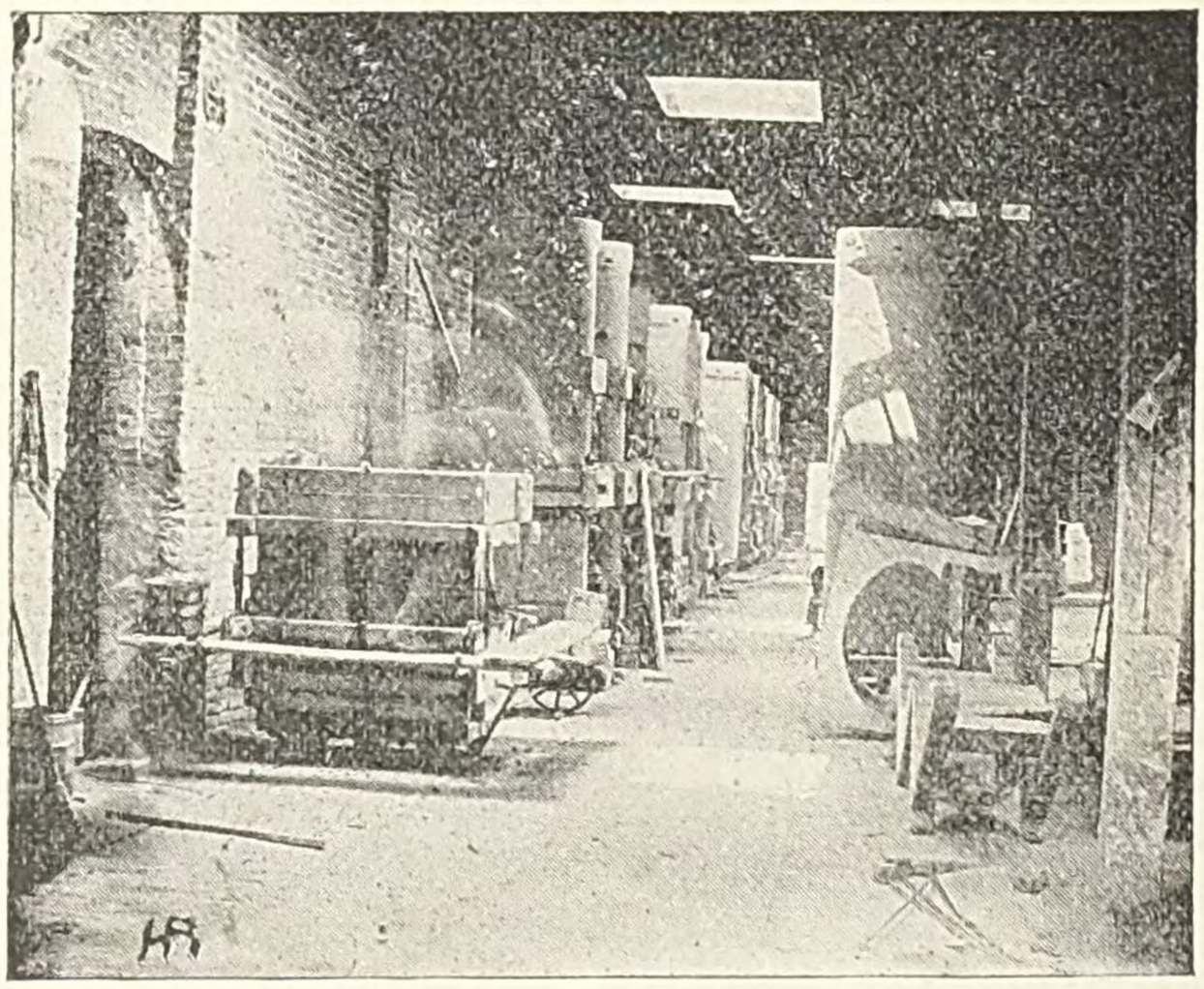
Other manufacturers of drain-tile and whose works have been already mentioned in the detailed account of brick yards, are:

M. H. Bender, Albany
William Davenport, Fonda
C. Stephens, South Bay
Rochester Brick and Tile Manufacturing Co., Rochester
A. Mosell, Lockport
Adams Brick and Terra Cotta Co , Buffalo
James Sigler, Clarkson
J. E. Mecusker & Son, Jamestown
B. G. Abbey, Allen's Hill
J. B. Lowe, Big Flats
P. Hayne, Goshen

## Fire Brick.

A fireclay to be refractory should not contain over four per cent. of impurities. Fireclays may or may not be plastic. The latter are represented by the flint clays, but these do not occur

in New York. Fireclays vary in color, being black, gray, red, green, blue or white. Many are soft and can be dug with pick and shovel while others are shale like in their nature and have to be blasted. Fireware must be able to withstand great and sudden changes of temperature. It should resist intense heat without shrinkage or fusion, and it should also resist corrosion of substances in a state of fusion. Coarsegrained ware resists temperature while finegrained ware can best withstand corrosion. If the fireclay is to be used for saggers it must make a product which will not crack when subjected to repeated alternations of heat and cold. The porosity of a fire brick is often caused by



Molding-room of Gas-retort Works.

coarse sand and may be remedied by the addition while preparing of ground burnt clay, or "cement clay" as it is called. Ground quartz may be added if the material contains an excess of alumina. Weathering the clay is of the utmost importance and is often carried on for several months. It breaks up the clay and tends to lessen shrinkage in burning. The clay is next tempered as a further step toward the production of a homogeneous brick. It is first passed between rollers to break it up and is further cut up in a ring pit together with sand. The material is next soaked in a pit with water. Several grades of clay are usually mixed in certain proportions in this pit, the amounts

added being the secret of the manufacturer. After soaking for a few hours the material is transferred to a pug mill for further tempering. The clay is now ready for molding. This is done by hand in wooden molds.

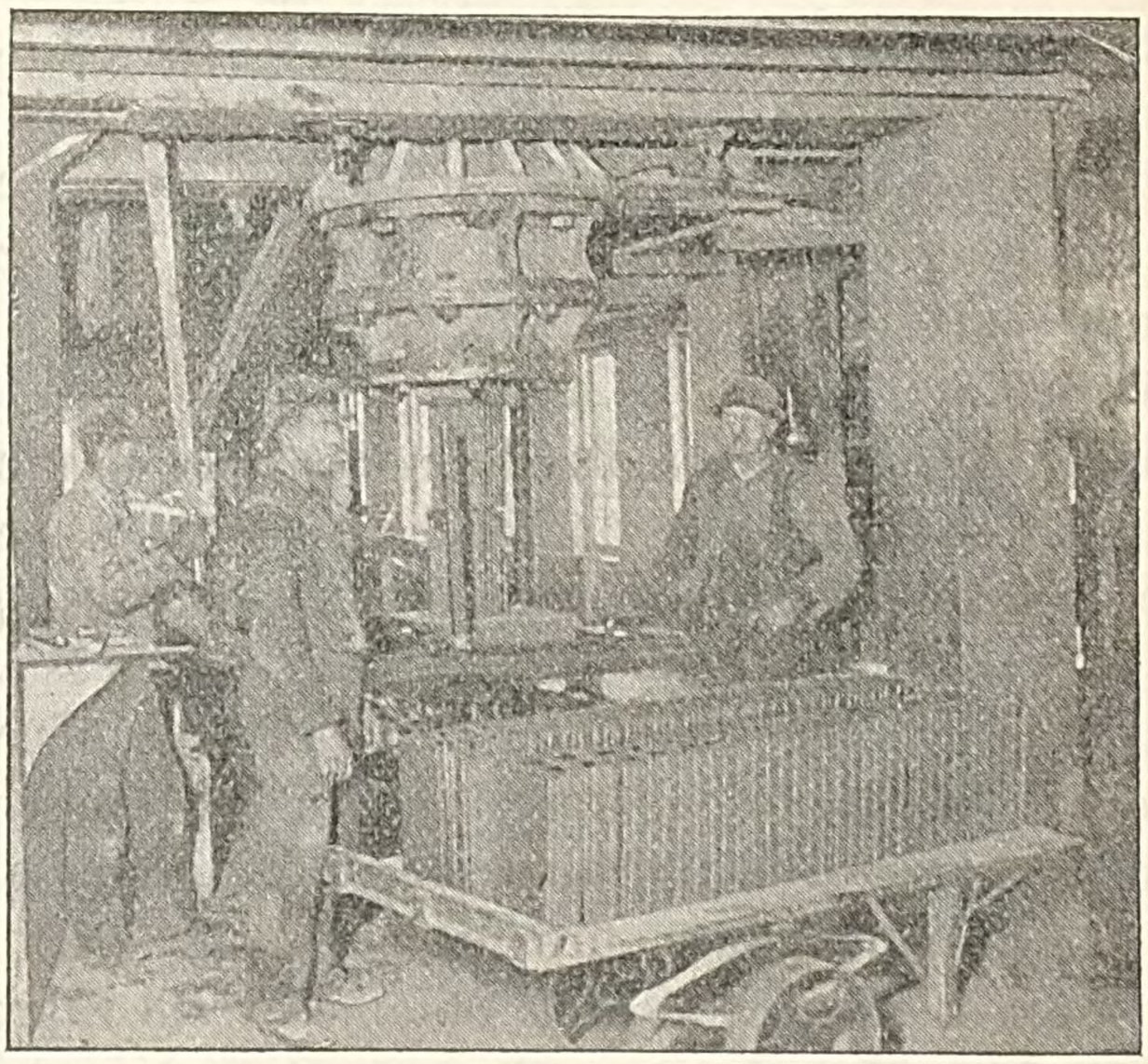
The chief object is to bring the mass of tempered clay into a convenient and approximately rectangular form before repressing it. Very little pressure is exerted in this handmolding. The bricks thus molded are spread out on a drying floor of brick, heated by flues passing underneath it. These brick are next repressed and further dried in tunnels before setting them in the kiln. The kilns are circular, having a height of 15 feet, and a diameter of 20 to 30 feet. Burning takes five to six days. The kiln has two openings, and while the burned brick are being taken out of one door the green brick are being carried in through the other one and set up for burning. The gas retorts are made by hand in sectional molds and burnt in the same kiln with the brick.

Although there are several fire brick factories in the state all of them with one exception obtain their clay from New Jersey. The New Jersey fire clays which are of Cretaceous age extend in a belt across New Jersey and over onto Staten Island, and it is at this latter locality that the refractory clays of New York state occur. The fire brick factory of William Kreischer's Sons is located on the southwestern shore of Staten Island at Kreischerville. They manufacture fire brick, cupola brick and gas retorts. Most of the clay used is obtained from Staten Island, and the rest from New Jersey. Four openings have been made in the vicinity of Kreischerville. The deepest one is opposite Kilmeyer's Hotel. The clay in this pit is used for fire brick. It is tough, of a whitish color and mottled with yellow. Its thickness is not very great and there is 15 or 20 feet of stripping. Southwest of this opening is another pit, but in this the clay is of a more sandy nature and is overlain by about four feet of sand. The clay is bluish in color and is chiefly used for mortar. A third opening has been made near the shore and is known as the "Wier Bank." The material obtained from it is a stoneware clay. In this pit the clay as at present exposed is about 10 feet thick, and is overlain by horizontally stratified fine sand.

## Sewer Pipes

Sewer pipes are made from a clay that will vitrify. There are several works in this state which import their clay from New Jersey. The two works described below use native clay.

*Angola.* John Lyth & Sons. The works are situated along the Lake Shore R. R. some few hundred feet southwest of the station. The material used is a Hamilton shale, of a gray color and containing streaks of bituminous matter. It is mined about 200 feet east of the factory, and a small blast serves to loosen a large quantity of it. Cars drawn by horses convey the shale to



Press for sewer pipe, tile and hollow brick

the dry pans where it is ground to a fine powder and is then further ground with the addition of water in a wet pan. The tempered material is then carried in a bucket ladder to the upper floor of the building where it is fed into the sewer pipe press. This consists of two vertical cylinders separated by iron frames. The upper cylinder contains the steam piston and is about 30 inches in diameter. The lower one is the clay cylinder. The area of the steam cylinder is usually several times greater than the area of the clay cylinder. The clay piston is a continuation of the steam one, and within the clay cylinder at its lower end is the bell which regulates the internal size of the pipe. Sockets

are made by means of a core attached to the end of the die, the bending of the pipe being caused by the core forcing the clay out through the die faster on one side than the other. Underneath the end of the cylinder is a counterpoised table which receives the pipe as it issues. When a sufficient length of pipe has issued the press is stopped and the pipe cut off at the mouth of the die. It is then removed from the table, which, relieved from the weight, ascends to receive another length of pipe. Y joints are made by hand, a hole being cut in the side of one piece of pipe and the end of another trimmed to fit over it, the joint being closed by means of wet clay.

After the pipes are molded they are set on the drying floors until thoroughly dry. Burning is done in circular down draft kilns, such as those described in the manufacture of brick. It takes five to eight days. The glaze to sewer pipe is made by adding salt to the fires toward the end of the burning and when the fires are hottest. The salt is thrown into the fireplace and by the heat is broken up into hydrochloric acid and oxide of sodium, and this latter fluxes with the silica in the pipe forming a vitreous coating known as the "salt-glaze." When sewer pipes are made of pipe clay, they are often coated with "Albany Slip," a calcareous clay obtained in the Hudson River Valley. The material composing this fuses at a lower temperature than the fire clay and gives the desired glaze. The composition of this material published in Vol. VII of Ohio Geol. Surv. 1893 is:

| | |
|---|---|
| Silica | 60.59 |
| Alumina | 12.46 |
| Oxide of iron | 5.79 |
| Lime | 6.84 |
| Magnesia | 3.28 |
| Alkalies | 4.39 |
| Water | 5.82 |
| | 99.17 |

Another analysis given in the Clay-worker of December, 1894:

| | |
|---|---|
| Silica | 58.47 |
| Alumina | 16.90 |
| Lime | 6.19 |
| Magnesia | Tr. |

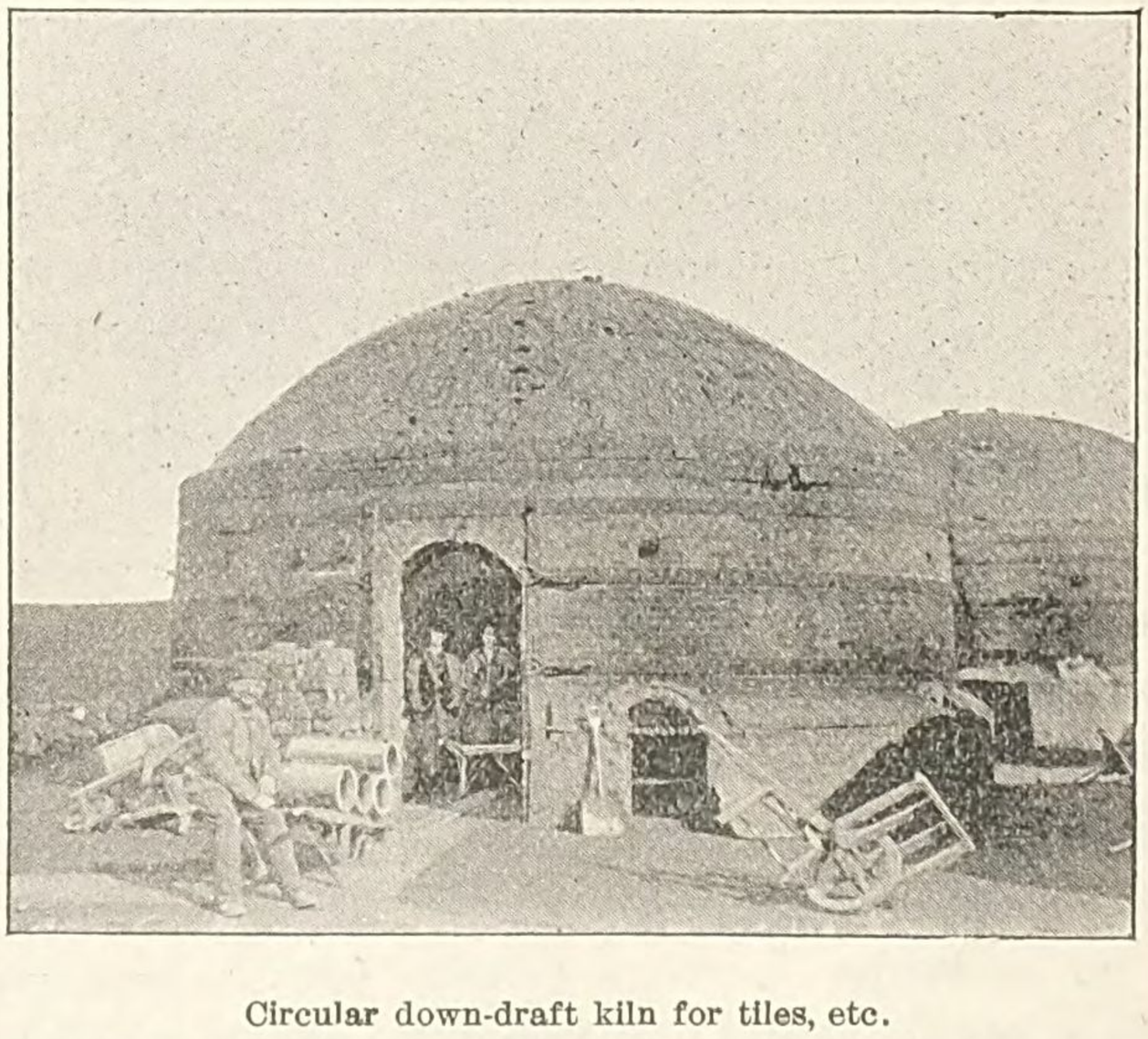
| | |
|---|---|
| Oxide of iron | 3.72 |
| Alkalies | 8.85 |
| Water | 7.49 |
| | 101.62 |

We give here an analysis of the shale at Lyth's yards:

| | |
|---|---|
| Silica | 65.15 |
| Alumina | 15.29 |
| Oxide of iron | 6.16 |
| Lime | 3.50 |
| Magnesia | 1.57 |
| Alkalies | 5.71 |
| | 97.38 |

J. Lyth & Son also manufacture hollow brick and terra cotta lumber.

*Rochester.* Otis & Gorsline use a mixture of New Jersey fire clay and a quarternary clay obtained from Chili near Roches-



Circular down-draft kiln for tiles, etc.

ter. The method of manufacture followed by them is very similar to that at Angola. Rectangular kilns are however used for burning, which takes about one week.

Sewer pipe are also manufactured at Albany and Troy but from New Jersey clays.

### Flower Pots

There is a deposit of mottled blue clay on Long Island between Southold and Greenport, which is used for manufacturing flower pots at the latter place. The clay at Oakland Valley on the land of O. B. Wheeler has also been used for this purpose. (*See* detailed account of brick yards.)

### Hollow Brick and Terra Cotta Lumber

A clay that will make a good building brick or drain-tile can generally be used for the manufacture of hollow brick. The same sort of machine is used in their manufacture as is used for drain-tile, a different shape of die being of course needed. The brick are made in various sizes and of rectangular cross section. They are manufactured by the following firms:

Wyandance Brick and Terra Cotta Co., Wyandance, Long Island,

J. E. Mecusker & Son, Jamestown,

Adams Brick and Terra Cotta Co., Buffalo,

Onondaga Vitrified Brick Co., Warners,

John Lyth & Sons, Angola.

Terra cotta lumber differs from the above in having about fifty per cent. sawdust added to the clay. This is burned out in the kiln giving a porous product. It is used for partitions and nails can be driven into it. Only two firms in New York are making it, viz. The Onondaga Vitrified Co. and John Lyth & Sons.

### Stoneware — Clay

Deposits of clay suitable for the manufacture of stoneware are found on Staten Island and Long Island. Those of S. I. are located at Kreischerville. The L. I. ones are found at Elm Point on Great Neck, Glen Cove and Little Neck near Northport. They are shipped to Poughkeepsie, Rochester, Utica and Ellenville in N. Y.; also at New Haven, Stamford, Norwalk and Hartford, Conn.; Newark, N. J.; and Pittston, Pa.

The Long Island clay is usually mixed with the Jersey clay in proportion of one to three. These latter clays, if used alone for the manufacture of stoneware, are apt to crack in burning, due to the unequal shrinkage and warping, while the Long Island

clays, being of a more sandy nature, prevent this. The clays of Long Island when used alone for the manufacture of stoneware give a creamy colored product, if burnt medium hard, but if burnt hard they produce a ware of a light blue or drab color. The sandy nature of the Long Island clays makes it difficult to turn them on the potter's wheel.

*Elm Point.* About one and a half miles northwest of Great Neck on Elm Point is a deposit of dark gray clay, worked by G. W. Mahan. The clay is overlain by about 20 feet of yellow gravel and drift. Lignite occurs abundantly in the clay, and nodules of pyrite are occasionally found. Several pits have been sunk in the clay, one of them 30 feet deep and 10 feet in diameter. Much of the clay is used by the New York Architectural Terra Cotta Co., at Ravenswood, Long Island, and some is also shipped to Boston where it is used for the manufacture of clay pipes.

*Glen Cove.* Carpenter Bros. have a bed of stoneware clay, fire sand and kaolin on the east side of Hempstead Harbor. The clay is of a white and pink color, the layers being four inches to one foot thick and interstratified with layers of quartz pebbles. Nearer the shore this dips under a bed of the clay free from pebbles. Associated with the clay is a deposit of kaolin and fire sand. The clay burns a cream color. The quartz pebbles which contain small cracks crumble easily and seem to have been subjected to the action of some alkaline solution.* When ground they can be used for the finest grades of pottery and stoneware. The fire sand and kaolin are screened and sold according to grade.

This clay is used chiefly for the manufacture of stoneware, it being shipped to various cities in Connecticut and New York states. It is also used by Perkins and Pit of Stamford, Conn., for the manufacture of stove linings. In this latter case about 15 per cent. of it is mixed with New Jersey clay. Under ordinary fire this clay burns to a light color, but with a hard fire it is said to blacken. The fire sand found associated with this clay bears a most excellent reputation as regards its refractory qualities.

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* F. J. H. Merrill. Geology of Long Island, Ann. N. Y. Acad. Sci., 1884.

*Northport.* The Northport Clay and Fire-sand Co. has an extensive series of pits on Little Neck near Northport. Both fire sand and clay are obtained. The clay bank has a height of about 40 feet and the clay is of a bluish black and yellowish white color. The darker clay is the lower, and contains much carbonaceous matter. The deposit is stratified, the layers of clay being separated by thin sheets of a rather coarse sand. It is shipped chiefly to New England.

The following are analyses of New York stoneware clays and Kaolin:

| | Elm Point. | Glen Cove. | Little Neck. | Kreischerville. | Kaolin Kreischerville. |
|---|---|---|---|---|---|
| Silica | 62.06 | 70.45 | 62.66 | 64.26 | 82.51 |
| Alumina | 18.09 | 21.74 | 18.09 | 24.76 | 11.57 |
| Oxide of iron | 5.40 | 1.72 | 0.97 | 0.83 | 0.63 |
| Lime | 1.05 | 0.24 | 0.79 | 0.73 | 0.29 |
| Magnesia | Trace. | 0.30 | ..... | Trace. | 0.78 |
| Alkalies | 6.11 | 5.00 | 2.23 | 2.35 | 2.66 |
| | 92.71 | 99.45 | 84.74 | 92.93 | 98.44 |

The following are analyses of Long Island stoneware clays made by C. H. Joüet (School of Mines Quart. Jan. 1895).

| | White clay from Northport | Black clay from Northport | White clay from Sea Cliff. |
|---|---|---|---|
| Silica | 68.34 | 58.84 | 62.35 |
| Alumina | 19.89 | 23.40 | 23.14 |
| Ferrous oxide | .90 | 1.18 | 1.12 |
| Lime | .35 | ..... | ..... |
| Magnesia | tr. | ..... | ..... |
| Carbonic acid | ..... | ..... | ..... |
| Sulphuric acid | ..... | 1.03 | 1.09 |
| Potash | 3.55 | 5.04 | 3.17 |
| Soda | .84 | .34 | 1.76 |
| Combined water | 6.03 | 9.20 | 6.77 |
| | 99.90 | 99.03 | 99.40 |

## Stoneware

The following description of the manufacture of stoneware and earthenware is quoted from vol. V of the Geological survey of Ohio.

"Stoneware is the product of an unmixed, natural clay, burnt at high enough heat to oblige the impurities to combine with the dry silica and thus cause an incipient vitrification or fretting without loss of shape. It should be impermeable to water without any glazing on it, but it frequently fails in this point. The color is bluish gray due to combined iron."

"Earthenware is a product of very similar clays burnt a little to vitrify the body or combine the iron. It is of a yellow or red color from the free iron and is porous unless glazed."

The successive steps in the manufacture of stoneware are

1. Wetting the clay.
2. Grinding.
3. Wedging.
4. Turning.
5. Drying.
6. Slipping.
7. Burning.
8. Sorting the product.

The wetting or soaking of the clay is usually done at small works where the grinding machines are operated by horse power. Several kinds of grinders are used for the clay, the simplest one being the pug mill. A machine often used at many potteries consists "of a square frame pivoted on an upright beam which runs through the point of crossing of the diagonals. On the projecting ends of this frame are fastened cart wheels which work in a circular trough beneath. The whole frame revolves by the motion of a large cog wheel above, which receives its power from the horse or engine. The machine is slowed up by weighting the corners of the frame. The wheels in their revolutions manage to cut the clay to pieces quite effectually." This machine has a capacity for grinding from 1,200 to 1,500 pounds

at a charge, taking two hours for the operation. Such a charge makes from 180 to 190 gallons of ware. The ground clay is rolled into masses and "wet blanketed" to keep until used. At some factories steam tracer mills are used for doing the grinding. They can grind about 1,200 pounds in 60 to 100 minutes, but eliminate blebs or substances in the clay and particles of foreign matter. The balls of clay are successively divided by a wire into two parts, these halves being each time struck together in such a manner that the two pieces unite different faces. The clay is next turned to the required shape. Crocks and fruit jars are the simplest kinds of product made and after that come jugs, milk-pans and churns. At small works the ware is often laid on flat boards in the sun to dry. At the larger works drying is usually done in closets or rooms heated by a series of steam pipes.

The dry ware now has to be slipped, that is to say, it is covered with a wash consisting of a very fine ground clay suspended in water. By this means the ware becomes covered with a film of clay. These slip clays vitrify easily to a black glaze which covers the ware. The slip commonly used is obtained from the Hudson river clays at Albany and a partial analysis of it is as follows:

| | |
|---|---|
| Sesquioxide of iron | 1.43 |
| Potash | 3.17 |
| Soda | .74 |
| | 5.34 |

There are also present large percentages of carbonates of lime and magnesia, which add to the fusibility of the clay. For other analyses see sewerpipe.

A difficulty experienced in the use of slip glazes is the tendency to blister. By many potters this is considered to be due to hasty burning, and it is thought by them that it may be overcome by heating the ware at a low red heat for several hours before raising the temperature. After this a rapid raising of the heat is harmless. The kilns in which the ware is burned vary consider-

ably in shape and size. At small works they are often small square structures. "The fireholes are left above ground and communicate through the various arches and masonry which separate the floor of the chamber above. This floor is full of holes, through which the fire passes and the gases escape through vents in the roof which is arched." Such a chamber is usually about eight feet in diameter and seven feet high. Firing is commenced at night and proceeds slowly at first. By morning the ware is fairly dry and the heat is then continued from 20 to 30 hours, according to conditions. The slip is usually applied only on the inside of stonewares, the outside being glazed with salt.

"The salt is thrown in the fire when heat is highest, the vapors are seized by the clay and the soda silicate forms over the surface of the ware. The heat required to do this is the culminating of the point of burning." Either coal or wood fuel is used. Many of the larger works use down-draft rectangular kilns for burning their wares. At Akron, Ohio, these are 32 by 16 feet and 12 feet high. The fireplaces are at each end and are six in number. The ware is set through lateral doors. Burning requires about 70 hours. It is considered that the cooling of a kiln should occupy as much time as the burning.

A common trouble, in addition to blistering of the slip, is the pitting of the ware in spots, due to iron. "It is a peculiarity of stoneware clay that while it needs iron to give it color by far the largest part of the iron present is collected in grains and has no favorable effect on the color. These grains, if the heat is high enough to vitrify them, pimple on the surface or break out in rough spots, which are black and ill-looking from the silicate of iron formed. If the heat is too low to vitrify the clay, the slow change in its volume by heat causes a scale to separate from the ware, causing a light colored cavity with the piece of the oxide of iron at the bottom."

"Failure of the ware to glaze is also considered due to irregular burning, but another cause is thought to act at times."

In many of the clays there is sulphate of lime present in the form of fine crystals of a whitish color. When exposed to the

vapors of salt at a high heat these change to a chloride of lime, leaving the soda as a sulphate, which will either not displace the silica through combination or will not do it at a temperature which the ware will stand without losing shape, and therefore no glaze is produced.

"Stoneware should exhibit on fracture a blue uniform tint of a somewhat vitrified appearance. This varies very often, however, with the clay."

## Terra Cotta

There are four companies in New York who are engaged in the manufacture of this product, viz.: the Celadon Terra Cotta Co., the Corning Brick Co., the New York Anderson Brick Co., the Glens Falls Terra Cotta Co., and the New York Architectural Terra Cotta Co. The first-mentioned company is gradually giving up the manufacture of terra cotta and turning its entire attention to roofing-tile.

The Corning Brick Co. makes its terra cotta from a Hamilton shale. The New York Anderson Brick Co. makes its ware from the Cretaceous stoneware clays of Staten Island; among the largest Terra Cotta works in the state are those of the Glens Falls Terra Cotta Co.; the clay used by them is a portion of the Hudson estuary deposit, it being of a bluish gray color with the upper portions weathered to red. We give herewith a partial analysis of their two clays.

| Bluish-gray. | | Red. |
|---|---|---|
| 48.35 | Silica | 57.46 |
| 11.33 | Alumina | 21.15 |
| 4.02 | Oxide of Iron | 5.52 |
| 15.38 | Lime | 3.65 |
| 3.17 | Magnesia | 1.50 |
| 1.18 | Organic Matter | ..... |
| 6.05 | Alkalies | 4.72 |
| 89.48 | | 94.00 |

The high percentage of lime in the bluish-gray clay enables them, by the use of it alone, to produce a light-colored ware,

while a mixture of the two clays gives a speckled product, and the red clay alone, a red product.

*New York Architectural Terra Cotta Company.* The works of this company are situated at Ravenswood, Long Island city. They use clays from both Long Island and New Jersey for the manufacture of terra cotta. The Long Island clay is obtained from Great Neck, L. I. It produces a ware of light yellow color. Coal was formerly used for burning the ware, but oil is now used instead. It is found that 160 gallons of oil is equal to one ton of coal. The advantage of oil is a saving of labor and time, and it is also more convenient and cleaner to use.

## The Manufacture of Terra Cotta

In order to produce a good quality of terra cotta, a clay should not whitewash; it should not shrink over one inch per ft. in burning, and should do so evenly; the shrinkage can be regulated by the addition of "grog," (pulverized brick, or sand). Clays which are too sandy can be washed; this is done by dumping them into a circular trough filled with water, in which there revolve paddles fastened to a vertical axis in the center of the trough; from the trough, launders run to settling vats.

The motion of the paddles drives the water with the suspended particles of clay into the launder, down which it flows to the vats, while the coarse sand remains behind in the trough; after the clay has settled in the vats, the water is drawn off; this is the method followed at Glens Falls. Before molding the clay, it should be thoroughly pugged, or, in other words, mixed, and after this the mass should be piled up and allowed to "cure," that is to say, it settles by its own weight, becoming denser while the excess of water evaporates.

The clay is next molded either by machine or by hand; the former method is used for plain forms, while the latter is used for ornamental styles of terra cotta.

Hand molding is of course slower, more difficult, and requires more care; plaster molds are used, and the clay is forced into all the corners with the hand or fingers.

The form is then allowed to remain in the mold until it has dried and shrunk sufficiently to drop out of it, or to permit the mold

being lifted off entire or in sections. The surface of the molded piece is then trimmed and smoothed, and it is put in the drying room until sufficiently dry to burn. Burning is done in down-draft kilns, and takes seven to nine days. The kiln has to be fired very cautiously at first to prevent the ware from cracking; and the heat within it is regulated by means of dampers on the roof and sides.

Large lumps of clay are placed just inside the doors of the kiln to serve as testers. When the burning is nearly done, one of these is withdrawn from time to time and allowed to cool, and from its appearance is determined whether the contents of the kiln are burnt enough; the kiln must be cooled very slowly in order to prevent the ware from cracking; when cool, the terra cotta is taken out and is ready for market.

The following are analyses of New York clays used for making terra cotta:

| | Alfred Center. | Glens Falls blue. | Glens Falls red. | Elm Point. |
|---|---|---|---|---|
| Silica | 53.20 | 48.35 | 57.46 | 62.06 |
| Alumina | 23.25 | 11.38 | 21.15 | 18.09 |
| Iron peroxide | 10.90 | 4.02 | 5.52 | 5.40 |
| Lime | 1.01 | 15.38 | 3.65 | 1.05 |
| Magnesia | .62 | 3.17 | 1.50 | Trace. |
| Alkalies | 2.69 | 6.05 | 4.72 | 6.11 |
| Sulphuric acid | .41 | ..... | ..... | ..... |
| Titanic acid | .91 | ..... | ..... | ..... |
| Water (comb) | 6.39 | ..... | ..... | ..... |
| Manganese oxide | .52 | ..... | ..... | ..... |
| Total | 99.90 | 88.30 | 94.00 | 92.71 |

## Roofing-tile

Alfred Centre is the only locality in New York at which roofing-tile are being manufactured. The Celadon Terra-Cotta Co. has been in operation for several years, and another factory has recently commenced operations. The material used is a mixture of local bluish gray clay and a Devonian shale. These two are thoroughly ground in dry pans, from which they are carried to

hoppers on the floor above. They are then fed to a pug mill which mixes the clay and shale, and the pugged material is fed directly to a stiff-mud machine. As the bar of plastic mixture issues from the machine it is cut up into slabs which go to the molding room. The Celadon Terra--Cotta Co. has six hand-power machines with a daily capacity of 1,500 each. As the slab of clay comes up from the stiff-mud machine it is taken by the workman who with a wooden tool pound a broad shallow groove in one surface, and then passes it to a second workman who puts it in the machine where it is pressed into shape between two steel dies, which are heated by steam. The repressed tile is taken from the machine by a lifter having two flat steel prongs and laid on a plaster frame held in readiness by a third workman. The latter hands it to another who trims the edges of the green tile with a knife. The tile and plaster frame are set on the racks in the drying room until placed in seggars for burning. Burning requires seven days, and is done in cupola kilns. The company also has a steam power tile pressing machine which has a daily capacity of 15,000. Tests of these tile were made at Columbia college and they showed a crushing resistance of 40,000 lbs. per square inch. The tiles are made of many patterns, and each style required a plaster frame to fit its shape, while drying.

## Appendix

Since the foregoing report was written in the latter part of 1892, there have been a few changes in the clay industry of New York that deserve mention.

In the manufacture of common brick, which constitutes the chief branch of the industry in this State, there has been little change; some of the manufacturers are substituting coal for wood as a fuel for kilns, and a few have given up open air drying and are using artificial means, in addition to those already doing so.

There were published in the Engineering News for Dec. 13, 1894, an exhaustive series tests of building and paving brick, many of the samples tested being from New York State.

The use of shale is steadily increasing. A paving brick plant with a daily capacity of 180,000 has recently been erected at Catskill, N. Y. The shale used is brought from Cairo, ten miles distant.

Experiments have also been made with the Niagara shale from Medina, N. Y. Sample lots were made into brick and then tested in the crushing machine, and gave very good results.

In the manufacture of fire brick the method of hand-molding and repressing are no longer used, but the bricks are molded in a soft mud machine. The time of manufacture is considerably lessened thereby as is also the selling price.

These are the principal changes which have occurred. There has been a favorable advance in all branches of the industry in this State.

# TABLE OF SECTIONS OF CLAY DEPOSITS

| LOCALITY | Owner | Thickness of clay, ft. | Color | Underlying material | Overlying material |
|---|---|---|---|---|---|
| Albany | T. McCarthy | 15 | Blue | Sand | Soil. |
| | A. Hunter | 40 | Blue and yellow | | Soil. |
| | M. Roberts | 25 | Blue | | Loose soil. |
| Greenbush | Mrs. T. Rigney | 90 | Blue and yellow | | Loam. |
| Troy | A. Ferguson | 40 | Blue and yellow | Slate | Loam. |
| | J. B. Roberts | 20 | Yellow | Gravel | 1 foot loam. |
| Cohoes | J. E. Murray | 50 | Blue | Slate | Loam. |
| | J. Baeby | 40 | Yellow and blue | Gravel | Soil. |
| Lansingburg | T. F. Morrissey | 75 | Red ⅓, blue ⅔ | 30 ft. sand | |
| Crescent | Newton Bros | 30 | Gray and blue | | 2-4 ft. sand. |
| Mechanicsville | Mechanicsville Brick Co. | 50 | Yellow 10 ft., blue 40 ft. | Sand | 3 feet soil. |
| Saratoga | C. L. Williams | 6 | Blue | Sand | 1 foot soil. |
| Middle Granville | J. H. Pepper | 45 | Blue | 20 ft. gray soil, slate | |
| Hoosick Falls | J. Dolin | 40 | | | |
| Plattsburg | J. Ouimet | 20 | Yellowish brown | | 1 foot soil. |
| Gouverneur | G. R. Thompson | 14 | Gray 8 ft., blue 6 ft | | Sand, 4 feet. |
| Carthage | Wrape & Peck | 5 | Gray | | |
| Watertown | Watertown Brick Co | 20 | Red | Trenton limestone | Soil. |
| Ogdensburg | Paige Bros | 60 | Blue | Limestone | Soil. |
| Madrid | R. Watson | 20 | Blue | | Sand 3 feet. |
| Raymondville | Coats Bros | 25 | Blue | | Fire sand 12 feet. |
| Breesport | Empire State Brick Co | 50 | Blue | | Soil. |
| Spencer | W. H. Bostwick | 6 | Red | Sand and gravel | Soil. |
| Newfield | T. C. Campbell | 40 | Blue | | Sand 4 feet. |
| Homer | H. Hall | 5 | Blue | Quicksand | Soil. |
| Binghamton | Wells & Brigham | 6 | Blue | Sand and gravel | Soil. |
| Goshen | P. Hayne | 55 | | Black gravel | Soil. |
| Florida | W. H. Vernon | 10 | Red and blue | Sand and hardpan | |
| Oakland Valley | O. B. Wheeler | 46 | Blue | | |
| New Paltz | New Paltz Brick Co | 40 | Red and blue | | Sand few feet. |
| Chittenango | Central N. Y. Drain-Tile Co | | Red | Sand | Soil. |
| Allen's Hill | B. G. Abbey | | Blue | | Soil. |
| Owasco | A. Lester | 10–15 | | | Gravel. |
| South Trenton | H. L. Garrett | 4 | Yellow, red, blue | Slate | |
| Amsterdam | H. C. Grimes | 6+ | Yellow and blue | | Soil 1–3 feet. |
| Gloversville | H. McDuffie | 2½ | Dark brown | Hardpan | Soil. |
| | W. A. Stoutner | 3 | Red brown | Hardpan | Soil. |
| Ilion | S. E. Coe | 8–15 | Black, gray and blue | | Few feet soil. |
| Rome | W. Armstrong | 7–10 | Dark gray | | |
| | W. W. Parry | 6–9 | | Gravel | Loam. |

| | | | | | |
|---|---|---|---|---|---|
| South Bay | C. Stephens | 25 | | Cemented blue gravel | |
| Syracuse | Preston Bros | 10 | Red and blue | Sand and gravel | Soil. |
| Warners | Onondaga Vitrified Brick Co | 15 | Red | Shale | Soil. |
| Oswego Falls | W. D. Edgerton | 5 | Yellow | Gravel | Soil. |
| Baldwinsville | Seneca River Brick Co. | ..... | Red and blue | Gravel | Soil. |
| Seneca Falls | F. Siegfried | 12 | | Gravel | Soil. |
| Lyons | F. Borck | 8 | Yellow and blue | Quicksand | |
| Canandaigua | Burke & Mead | 20 | Red and blue | Sand | 1 foot peat. |
| Rochester | Rochester Brk. Mfg. Co. | 5 | Red | Hardpan | |
| Tonawanda | M. Riesterer | 5 | Red and blue | | Soil. |
| Buffalo | Brush Bros. | 6–20 | Red | | Soil. |
| Evans | W. Bolton | 10 | Blue | Sand and gravel | Soil. |
| Dunkirk | W. Hilton | 20 | Yellow and blue | Rock | |
| Jamestown | J. E. McCusker & Son | 75 | Yellow 5, blue 70 | Hardpan | Yellow sand 4 feet. |
| Big Flats | J. R. Lowe | 75 | Gray and blue | | |

# DIRECTORY OF BRICK

O. Y. = Open Yard;
T. D. = Tunnel Dryers;
D K. = Down Draft kiln;
W. C = Wire-cut machine;
F. = Front brick;

P. Y. = Pallet Yard;
S. K. = Scove Kiln;
S. M. = Soft mud machine;
H. P. = Horse power;

| Post-office | MANUFACTURER | Product | Market |
|---|---|---|---|
| **SUFFOLK** | | | |
| Fisher's Island | Fisher's Island Brick Co. | C | N. Eng. |
| Greenport | L. I. Brick Co. | " | Conn. & S. I |
| Southold | C. L. Sanford | " | " |
| Fresh Pond | G. Longbottom | " | " |
| | R. Sammis. | " | " |
| Wyandance | Wyandance Brick and Terra Cotta Co. | " & rep brk. | L. I. |
| Farmingdale | M. Myers | C | " |
| **QUEENS** | | | |
| Co'd Spring Harbor. | Dr Oliver Jones | C | N. Y. C. & S. I |
| Oys er Bay | Dunn, Dolan & Co. | " | " |
| Co'd Spring. | W. Hammond | " | " |
| East Williston | W. & J. Post. | " | L. I. & N. Y. C |
| **WESTCHESTER** | | | |
| Croton Landing | Anchor Brick Co. | C | N. Y. C. |
| | Croton Brick Co | C & F | " |
| | W. A Underhill Brick Co. | " | " |
| Crugers | W. H. Fisher | C | " |
| | C. Carman | " | " |
| Montrose | Lynch & King | " | " |
| | O. & C. Frost | " | " |
| | Montrose Brick Co. | " | " |
| | C. Hyatt | " | " |
| | J. Morton | " | " |
| Verplank | King & Lynch | " | " |
| | A. Fisher. | " | " |
| | T. N Avery | " | " |
| | B. J. McGuire | " | " |
| | J. Morton | C. & F. | " |
| | S. Travers | C | " |
| | McConnell & O'Brien. | " | " |
| Peekskill | ole & Bonner | " | " |
| | Oldfield Bros. | " | " |
| | Bonner Brick Co. | " | " |
| **ROCKLAND** | | | |
| Haverstraw | H. Cristie | C | N. Y C., few to N. J. |
| | J. Felter | " | N. Y. C. |
| | P. Lynch | " | " |
| | Shankey, Kelly & Renn | " | " |
| | Denton, Fowler & Son | " | " |
| | Excelsior Brick Co. | " | " |
| | F. Frederick | " | " |
| | A. Donnelly & Son | " | " |
| | F. McGuire & Sons | " | " |
| | Murray & Morrissey | " | " |
| | G. I. Sherwood | " | " |
| | G. Archer | " | " |
| | Sneder Bros | " | " |
| | C. D & G Archer | " | N.Y C , N. J.& N. Eng. |
| | B. J. Allison & Co | " | N. Y. C. |
| | Allison, Wood, Keenan & Co. | " | " |
| | Wood & Keenan | " | " |
| | Bennett, Rowan & Scott | " | " |
| | owler & Washburn | " | " |
| | D amond Brick Co | F. & C. | " |
| | Kelly & Byrnes | C | " |
| | T. C McGuire | " | " |
| | M. F. & L. F. Washburn | " | " |
| | Carr & Smith | " | " |

# MANUFACTURERS.

D. T. = Drain tile;
C. Y. = Covered yard;
Cl. = Clamp;
D. M. = Dry Clay machine;
C. = Common brick;
S. P. = Sewer pipe;
T. = Terra-cotta;
R. T. = Roofing tile.

**COUNTY**

| Machine used | System of drying | Kind of kilns | Fuel | Remarks |
|---|---|---|---|---|
| S. M. | O. Y. | S. K. | Wood | |
| " | " | " | " | |
| " | P. | " | " | |
| " | O. Y. | " | " | |
| " | " | " | " | |
| S. M. & W. C. | Steam | Wingard K. | Coal | |
| " | P. Y. | | | |

**COUNTY**

| | | | |
|---|---|---|---|
| S. M. & W. C. | O. Y. | S. K. | Wood |
| " | " | " | " |
| " | " | " | " |
| " | O. & P. Y. | " | " |

**COUNTY**

| | | | |
|---|---|---|---|
| S. M. & W. C. | C. Y. | Cl. | Coal |
| " | P. & O. Y. | S. K. | Wood |
| " | C. Y. | Cl. | Coal & wood |
| S. M. | O. Y. | S. K. | Wood |
| " | " | " | " |
| " | " | " | " |
| " | C. Y. | " | " |
| " | P. Y. | " | " |
| " | O. Y. | " | " |
| " | " | " | " |
| " | " | " | " |
| " | " | " | " |
| " | " | " | " |
| " | " | " | " |
| " | C. Y. | " | " |
| " | O. Y. | " | " |
| " | " | " | " |
| " | " | " | " |
| " | " | " | " |
| " | " | " | " |

**COUNTY**

| | | | |
|---|---|---|---|
| S. M. | O. Y. | S. K. | Wood |
| " | " | " | " |
| " | " | " | " |
| " | C. Y. | " | " |
| " | " | " | " |
| " | O. Y. | " | " |
| " | " | " | " |
| " | " | " | " |
| " | " | " | " |
| " | " | " | " |
| " | " | " | " |
| " | " | " | " |
| " | " | " | " |
| " | C. Y. | " | " |
| " | P. Y. | " | " |
| " | O. Y. | " | " |
| " | Hot air tun. | " | " |
| " | O. Y. | " | " |
| " | " | " | " |
| " | " | " | " |
| " | " | " | " |

**ROCKLAND**

| Post-office | MANUFACTURER | Product | Market |
|---|---|---|---|
| Haverstraw | Morrissey & Co | C | N. Y. C |
| | P. Brophy | " | " |
| | Dolan, Dunn & Butler | " | " |
| | T. & C. Peck | " | " |
| | T. Malley | " | " |
| | P. Goldrick | " | " |
| | T. & G. Peck & Co | " | N. Y. C. & N. J |
| | Buckley & Carroll | " | N. Y. C. |
| | T. Clark | " | " |
| | J. Brennan | " | " |
| | P. Ohler | " | " |
| | D. Fowler Jr. & Washburn | " | " |
| | J. Shankey & Son | " | " |
| Stony Point | C. A. Marks | " | " |
| | Riley & Clark | " | N. Y. C. ⅔ |
| | Riley & Rose | " | " |
| | Allison, Wood & Allison | " | N. Y. C. |
| Thiells | Felter & Mather | " | Patterson & Passaic |

**ORANGE**

| | | | |
|---|---|---|---|
| Cornwall | C. A. & A. P. Hedges | C | N.Y.C. & N.Y.,O.& W. |
| New Windsor | J. A. Whitbeck | " | Newburgh |
| | E. Lang | " | N. Y. C. |
| | J. T. Moore | " | " |
| | Q. Davidson's Sons | " | " |
| | Moore & Lahey | " | " |
| | D. Carson | " | " |
| Goshen | P. Hayne | C. D. T | Vicinity |
| Florida | W. H. Vernon | C | " |
| Roseton | Rose & Co | " | N. Y. C. |
| | J. J. Jova | " | " |

**DUTCHESS**

| | | | |
|---|---|---|---|
| Storm King | Mosher Bros | C | N. Y. C. |
| Dutchess Junct | T. Timoney | " | " |
| | L. Van Buren | " | " |
| | Covert Bros | " | " |
| | Aldridge Bros. & Co | " | " |
| | Barnacue & Dow | " | " |
| | Carman & Denton | " | " |
| | W. D. Budd | " | N. Y. C. & Ct |
| Fishkill | Denning Pt. Br'ck Co | " | N. Y. C. |
| | Harris & Gidley | " | " |
| | W. H. Aldridge | " | " |
| | J. P. Sherman | " | " |
| | O'Brien, McConnell & Vahey | " | " |
| | Brockway Brick Co | " | " |
| | Lahey Bros | " | " |
| | Dinan & Butler | " | " |
| Low Point | J. V. Meade | " | " |
| | C. E. Griggs & Co | " | " |
| Arlington | Flagler & Allen | " | Local |
| Amenia | Amenia Brick Co | " | Harlem R. R. |

**COLUMBIA**

| | | | |
|---|---|---|---|
| Hudson | J. Fitzgerald's Sons | C | N. Y. C. |
| | Arkison Bros | " | " |
| | W. E. Bartlett | " | " |

**RENSSELAER**

| | | | |
|---|---|---|---|
| Stockport | Walsh Bros | C | N. Y. C. |
| Stuyvesant | E. Brousseau | " | " |
| Greenbush | Mrs. T. Rigney | " | Albany & N. Y. C. |
| Troy | A. Ferguson | " | Vicinity |
| Lansingburg | T. Morissey | " | |
| Hoosick Falls | J. Dolin | " | |

**ULSTER**

| | | | |
|---|---|---|---|
| Port Ewen | S. D. Coykendall | C | N. Y. C. |
| | J. Kline | " | " |
| East Kingston | W. Hutton | " | N. Y. C. & local |
| | Terry Bros | " | " |

**COUNTY** — (*Continued*)

| Machine used | System of drying | Kind of kilns | Fuel | Remarks |
|---|---|---|---|---|
| S M | O. Y | S K | Wood | |
| " | " | " | " | |
| " | " | " | " | |
| " | P. Y | " | " | |
| " | O. Y | Cl | " | |
| " | " | " | " | |
| " | " | " | " | |
| " | " | " | " | |
| " | " | " | " | |
| " | " | " | " | |
| " | " | " | " | |
| " | " | " | " | |
| " | " | " | " | |
| " | " | " | " | |
| " | " | " | " | |
| " | C. Y | S. K | " | |
| " | O. Y | " | " | |
| " | " | " | " | |

**COUNTY**

| | | | | |
|---|---|---|---|---|
| S. M | O. Y | S. K | Wood | |
| " | " | " | " | |
| " | " | " | " | |
| " | " | " | " | |
| " | C. Y | " | " | |
| " | O. Y | " | " | |
| " | C. Y | " | " | |
| S. M. & W. C | O. Y | " | " | 2½ |
| " | " | " | " | 1 |
| S. M | " | " | " | |
| " | " | " | " | |

**COUNTY**

| | | | | |
|---|---|---|---|---|
| S. M | O. Y | S. K | Wood | |
| " | " | " | " | 1500 ft. |
| " | " | " | " | 40 A. land |
| " | " | " | " | 450 ft. front |
| " | " | " | " | 250 " " |
| " | " | " | " | 800 " " |
| " | " | " | " | 700 " " |
| " | " | " | " | |
| " | " | " | " | 26 A. land |
| " | " | " | " | 18 A. |
| " | " | " | " | 300 ft. front |
| " | " | " | " | " " |
| " | " | " | " | 500 " " |
| " | P. Y | " | " | 1200 " " |
| " | O. Y | " | " | 650 " " |
| " | P. Y | " | " | 475 " " |
| " | O. Y | " | " | |
| " | " | " | " | 100 A. |
| " | " | " | " | Horsepower |
| " | " | " | " | 4 |

**COUNTY**

| | | | | |
|---|---|---|---|---|
| S. M | O. Y | S. K | Wood | 12 A. |
| " | " | " | " | |
| " | " | " | " | |

**COUNTY**

| | | | | |
|---|---|---|---|---|
| S. M | O. Y | S. K | Wood | |
| " | " | " | " | 2½ A. |
| " | " | " | " | H. P. 1½ A. |
| " | " | " | " | 6 A. |

**COUNTY**

| | | | | |
|---|---|---|---|---|
| S. M | O. Y | S. K | Oil | |
| " | " | " | Coal | |
| " | " | " | Wood | |
| " | " | " | " | |

**ULSTER**

| Post-office | MANUFACTURER | Product | Market |
|---|---|---|---|
| East Kingston | R. Maine & Co | C | N. Y. C |
| | A. S. Staples | " | " |
| | C. A. Schultz | " | " |
| | Brigham Bros | " | " |
| | D S Manchester | " | " |
| | Streeter & Hendrix | " | " |
| | D. C. Overbaugh | " | " |
| | A Rose & Co | " | " |
| | C H. Littlefield | " | " |
| Glasco | U. F. & J. T. Washburn | " | " |
| | T. Porter | " | " |
| | F. N. Van Dusen | " | " |
| | Washburn Bros | " | N. Y. & J. C. |
| Malden | Cooney & Farrell | " | N. Y. C. |
| Smith's Dock | T. Brousseau | " | " |

**GREENE**

| | | | |
|---|---|---|---|
| Catskill | A. McClean | C | N. Y. C. |
| | Ferier & Golden | " | " |
| | Derbyshire Brick Co. | " | " |
| Athens | W. Ryder | " | " |
| | J. R. Porter | " | " |
| Coxsackie | F. W. Noble | " | " |

**ALBANY**

| | | | |
|---|---|---|---|
| Coeyman's Landing | Corwin & Cullough | C | N. Y. C. |
| | M. J. Sutton & Co. | " | " |
| | J. A. Brower | " | " |
| | H. Slingerland | " | " |
| | S. K. Brower | " | " |
| | Sutton & Suderly | " | " |
| Albany | T. McCarthy | " | Albany |
| | M. H Bender | C., F., D. T. | " |
| | J. Babcock | C | " |
| | E Smith | " | " |
| | D. H. Stanwix | " | " |
| | J. C. Moore | C. & F. | " |
| Cohoes | J. Baeby | C | V |

**SCHENECTADY**

| | | | |
|---|---|---|---|
| Crescent | Newton Bros | C | |
| Niskayuna | J. E. Winne | " | Schenectady |

**SARATOGA**

| | | | |
|---|---|---|---|
| Mechanicsville | Mechanicsville Brick Co. | C | Neighboring towns... |
| Saratoga | C. L. Williams | " | " ... |

**WARREN**

| | | | |
|---|---|---|---|
| Glens Falls | Glens F. Br. & Terra Cotta Co. | C., F., T. | N. Y. State |

**WASHINGTON**

| | | | |
|---|---|---|---|
| Mid. Granville | J. H. Pepper | C | |

**CLINTON**

| | | | |
|---|---|---|---|
| Plattsburg | J. Ouimet | C | Local |
| | C. Vaughn | " | " |
| | Gilliland & Day | " | " |

**FULTON**

| | | | |
|---|---|---|---|
| Gloversville | Wm. Stoutner | C | Local |

**MONTGOMERY**

| | | | |
|---|---|---|---|
| St Johnsville | J. Smith, J. McDuffie | C | Local |
| Fonda | | | |
| Amsterdam | | | |

**HERKIMER**

| | | | |
|---|---|---|---|
| Herkimer | J. J. Mabbett | | |
| Ilion | S. E. Coe | C | Local |

**COUNTY** — *(Continued)*

| Machine used | System of drying | Type of kiln | Fuel | Remarks |
|---|---|---|---|---|
| S. M. | O. Y. | S. K. | Wood | 5 A. land |
| " | " | " | " | |
| " | " | " | " | A few go to N. J. |
| " | " | " | " | |
| " | " | " | " | |
| " | " | " | Coal | |
| " | P. Y. | " | Wood | |
| " | " | " | " | 12 A. land |
| " | O. Y. | " | " | Staated in '91 |
| " | " | " | " | 60 A. land |
| " | " | " | " | Staated in '91 |
| " | " | " | Coal | |
| " | O. Y. & P. Y. | " | Wood | 150 A. land |
| " | O. Y. | " | " | Staated in '91 |
| " | " | " | " | |

**COUNTY**

| | | | | |
|---|---|---|---|---|
| S. M. | O. Y. | S. K. | Wood | 12½ A. land |
| " | " | " | " | |
| " | O. Y. & C. Y. | " | " | |
| " | O. Y. | " | " | |
| " | " | " | " | |
| " | " | " | " | |

**COUNTY**

| | | | | |
|---|---|---|---|---|
| S. M. | O. Y. | S. K. | Wood | |
| " | " | " | " | |
| " | " | " | Coal | |
| " | " | " | " | |
| " | " | " | " | |
| " | " | " | " | |
| S. M. | " | " | Wood | 4 A. land |
| S. M. & W. C. | " | S K, D. K. | Wood & coal | 2 A. land |
| S. M. | " | S. K | Wood | 1½ A. land |
| " | " | " | " | 2 A. land |
| " | " | " | " | 1½ A. land |
| " | " | " | " | 4 A. land |
| " | " | " | " | |

**COUNTY**

| | | | |
|---|---|---|---|
| S. M. | O. Y. | S. K. | Wood |
| " | " | " | " |
| " | " | " | " |

**COUNTY**

| | | | |
|---|---|---|---|
| S. M. | P. Y. | S. K. | Wood |
| " | " | " | " |

**COUNTY**

| | | | |
|---|---|---|---|
| S. M., D. P. | T. D. | Cl., C. K. | Coal |

**COUNTY**

| | | | |
|---|---|---|---|
| | | | |

**COUNTY**

| | | | |
|---|---|---|---|
| S. M. | O. Y. | S. K. | Wood |
| " | " | " | " |
| " | " | " | " |

**COUNTY**

| | | | |
|---|---|---|---|
| S. M. | O. Y. | S. K. | Wood |

**COUNTY**

| | | | |
|---|---|---|---|
| " | " | " | " |

**COUNTY**

| | | | |
|---|---|---|---|
| | | | |

**ONEIDA**

| Post-office | MANUFACTURER | Product | Market |
|---|---|---|---|
| Sangerfield | | C | |
| South Trenton | H. L. Garrett | " | |
| Utica | F. Borck | " | |
| Rome | W. W. Parry | C., F. | |

**MADISON**

| | | | |
|---|---|---|---|
| Chittenango | Central N. Y. Drain Tile Co. | D. T | |
| South Bay | C. Stephens | C | |

**ONONDAGA**

| | | | |
|---|---|---|---|
| Syracuse | Onon. Vit. Brick Co | C., P | N. Y. |
| | N. Y. Paving Brick Co | P | " |
| | F. H. Kennedy | C | Syracuse |
| | Preston Bros | " | " |
| | T. Nolan | " | " |
| | C. L. Merrick | " | " |
| | J. Brophy | " | " |
| Baldwinsville | Seneca River Brick Co | F | " |
| Camillus | | | |

**CAYUGA**

| | | | |
|---|---|---|---|
| Auburn | J. Harvey | C | |
| Owasco | A. Lester | " | |

**MONROE**

| | | | |
|---|---|---|---|
| Rochester | Roch. Brick & Tile Mfr. Co. | C | Local |
| | German Brick & Tile Mfr. Co | " | " |
| | Rochester Sewer Pipe Works, | | |
| Maplewood | Robe t Gay | " | " |
| Clarkson | J. Sieg er | C., D. T | |

**NIAGARA**

| | | | |
|---|---|---|---|
| Lockport | A. Mosell | C | Local |
| Niagara Falls | R. P. Slater | " | " |
| La Salle | Tompkins & Smith | " | " |

**ERIE**

| | | | |
|---|---|---|---|
| Tonawanda | M. Riesterer | C | Vicinity |
| Buffalo | has. Berrick & Sons | " | " |
| | Brush Bros. | " | " |
| | H. Dietschler & Son | " | " |
| | F. Haake. | " | " |
| | L. Kirkover | " | " |
| | Schusler & Co | " | " |
| | C W. Schmidt | " | " |
| | Adams Brk. & Ter. Cot Co. | C, F., D. T. | " |
| Black Rock | Black Rock Sewer Pipe Co. | Sewer pipe | |
| Lancaster | Lancaster Brick Co | C | Buffalo & vicinity |
| | Buffalo Star Brick Co | " | " |
| Angola | John Lyth & Sons | S. P., H. B., D. T. | N. Y. State |
| Evans | Wm. Bolton | C | Local |
| Jewettville | Brush & Smith | F. & C | |

**CHAUTAUQUA**

| | | | |
|---|---|---|---|
| Dunkirk | Wm. Hilton | F. & C | Local |
| Jamestown | J. E. McCusker & Son | F, C, D. T, H. B | " |
| | C. A Morley | C | " |

**CATTARAUGUS**

| | | | |
|---|---|---|---|
| Randolph | J. Turner | C | Local |

**GENESEE**

| | | | |
|---|---|---|---|
| East Bethany | B. F. Peck | D. T | Local |

| Machine used | System of drying | Type of kiln | Fuel | Remarks |
|---|---|---|---|---|
| **COUNTY** | | | | |
| S. M., W. C..... | | S. K..... | | |
| **COUNTY** | | | | |
| | | | | |
| **COUNTY** | | | | |
| W. C..... | T. D..... | D. K..... | Coal ..... | |
| S. M..... | " ..... | " ..... | " ..... | |
| " ..... ..... | O. Y..... | S. K..... | Wood..... | |
| " ..... | " ..... .. | " ..... | " ..... | |
| " ..... | " ..... | " ..... | " ..... | |
| " ..... | " ..... ..... | " ..... | " ..... | |
| " ..... ..... | " ..... | " ..... | " ..... | |
| D. M,..... | | D. K..... | Coal ..... | |
| **COUNTY** | | | | |
| | | | | |
| **COUNTY** | | | | |
| S. M..... | O. Y..... | S. K..... | | |
| " ..... | " ..... | " ..... | | |
| " ..... | " ..... | " ..... | | |
| **COUNTY** | | | | |
| S. M..... | O. Y..... | S. K..... | | |
| " ..... ..... | " ..... | " ..... | | |
| " ..... | " ..... | " ..... | | |
| **COUNTY** | | | | |
| S. M..... | O Y..... | C ..... | Coal ..... .... | |
| " ..... ... | P. Y..... | S. K ..... | " ..... | |
| " ..... | " ..... | " ..... | " ..... | |
| " ..... | " ..... | " ..... | " ..... | |
| " ..... | " ..... | " ..... | " ..... | |
| " ..... | " ..... | " ..... | " ..... | |
| " ..... | " ..... | " ..... | " ..... | |
| " ..... .... | " ..... | " ..... | " ..... | |
| S. M., D. M., W. C.. | 1 P. Y ..... | O. K. & S. K... | " ..... | |
| S. M..... | P. Y..... | S. K..... | Wood..... | |
| " ..... | " ..... | " ..... | " ..... | |
| | Drying rooms .. | Cupola Kilns ... | Coal ..... | |
| " ..... | O Y..... | S. K ..... | Wood..... | |
| D. M ..... | T. D..... | S. K , D. K..... | Coal ..... | |
| **COUNTY** | | | | |
| S. M ..... .... | B. Y..... | S. K..... | Coal ..... | |
| S. M., W C..... | P. Y..... ... . | S K , D. K ..... | Coal & wood..... | |
| S. M..... | " ..... | S. K..... | Wood..... | |
| **COUNTY** | | | | |
| | | | | |
| **COUNTY** | | | | |
| W. C..... | | | | |

**ALLEGANY**

| Post-office | MANUFACTURER | Product | Market |
|---|---|---|---|
| Alfred | Rock Cut Clay Co | F | |
| Alfred Centre | Celadon Terra Cotta Co | T. & R. T. | All over |

**STEUBEN**

| | | | |
|---|---|---|---|
| Hornellsville | Hornellsville Brick Co | P. & C | N. Y. State |
| | W. H. Signor | C | Local |
| Corning | Corning Brick Co | C. & T. C. | " |

**ONTARIO**

| | | | |
|---|---|---|---|
| Canandaigua | Burke & Meade | F | Local |
| Allen's Hill | B. G. Abbey | C | |
| Geneva | Torry Park Land Co | " | |

**CHEMUNG**

| | | | |
|---|---|---|---|
| Horseheads | R. G. Eisenhardt | C | |
| Breesport | Empire State Brick Co | " | Local |
| | P. M C. Townsend | " | " |
| | Locy Bros | " | " |

**TOMPKINS**

| | | | |
|---|---|---|---|
| Newfield | T. B. Campbell | F | Local |

**TIOGA**

| | | | |
|---|---|---|---|
| Spencer | W. H. Bostwick | C | Local |

**CORTLAND**

| | | | |
|---|---|---|---|
| Homer | Horace Hall | C | |

**BROOME**

| | | | |
|---|---|---|---|
| Binghamton | Ogden Brick Co | C | Local |
| | Wells & Brigham | " | " |

**OTSEGO**

| | | | |
|---|---|---|---|
| Oneonta | Crandall & Marble | C | Local |
| | J. Denton & Son | " | |

**OSWEGO**

| | | | |
|---|---|---|---|
| Oswego Falls | W. D. Edgarton | C. & F | Local |

**JEFFERSON**

| | | | |
|---|---|---|---|
| Carthage | Wrape & Peck | | |
| Watertown | Watertown Brick Co | C | Local |

**ST. LAWRENCE**

| | | | |
|---|---|---|---|
| Ogdensburg | Paige Bros | C | Local |
| Madrid | Robert Watson | " | " |
| Raymondville | Coats Bros | " | " |

**COUNTY**

| Machine used | System of drying | Kind of kiln | Fuel | Remarks |
|---|---|---|---|---|
| D. M..... | | D. K..... | Coal ..... | |
| Tile machine ..... | Hot rooms..... | D. K..... | " ..... | |

**COUNTY**

| | | | | |
|---|---|---|---|---|
| W. C..... | Tunnel D..... | D. K..... | Coal ..... | |
| W C. & S. M..... | O Y..... | S. K..... | Wood..... | |
| S. M..... | T. D..... | S. K..... | " ..... | |

**COUNTY**

| | | | | |
|---|---|---|---|---|
| D. M..... | | S. K. & D. K... | Oil ..... | |

**COUNTY**

| | | | | |
|---|---|---|---|---|
| S. M..... | T. D..... | S. K ..... | Wood..... | |
| " ..... | O. Y. ..... | " ..... | " ..... | |
| " ..... | T. D..... | " ..... | " ..... | |

**COUNTY**

| | | | | |
|---|---|---|---|---|
| W. C..... | T. D..... | Cl. & S. K..... | Coal ..... | |

**COUNTY**

| | | | | |
|---|---|---|---|---|
| S. M..... | P. Y..... | Cl ..... | Coal ..... | |

**COUNTY**

| | | | | |
|---|---|---|---|---|
| | | | | |

**COUNTY**

| | | | | |
|---|---|---|---|---|
| S. M..... | T. D..... | S. K..... | Wood..... | |
| " ..... | P. Y..... | " ..... | " ..... | |

**COUNTY**

| | | | | |
|---|---|---|---|---|
| | | | | |

**COUNTY**

| | | | | |
|---|---|---|---|---|
| S. M..... | O. Y..... | S. K..... | Wood..... | |

**COUNTY**

| | | | | |
|---|---|---|---|---|
| S. M..... | P. Y..... | S. K..... ..... | Wood..... | |

**COUNTY**

| | | | | |
|---|---|---|---|---|
| S. M..... | O. Y..... | S. K..... | Wood..... | |
| " ..... | " ..... | " ..... | " ..... | |
| " ..... | " ..... | " ..... | " ..... | |

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4

# MAP
OF THE
# STATE OF NEW YORK
SHOWING THE
## LOCATION OF CLAY DEPOSITS
AND
## MANUFACTORIES
BY
HEINRICH RIES

1893

Scale of Miles
5 0 5 10 15 20 25 30 35

Clay deposits only
Clay deposits and manufactories
Refractory clays

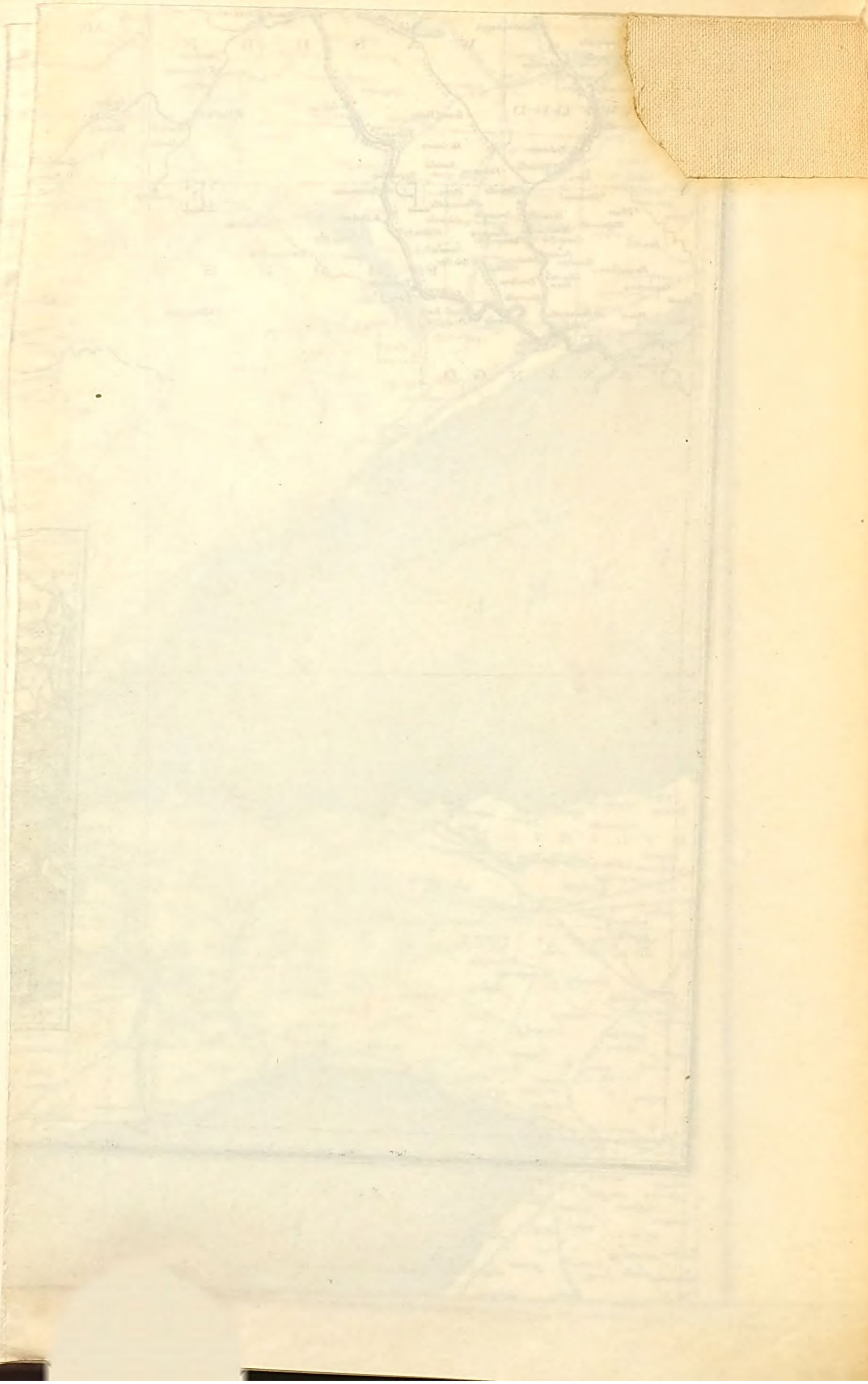
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University of the State of New York

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OF THE

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Vol. 3 No. 13

April, 1895

## THE SAN JOSE SCALE, Aspidiotus perniciosus

AND

## SOME OTHER DESTRUCTIVE SCALE-INSECTS OF THE STATE OF NEW YORK

BY

J. A. LINTNER, Ph. D., State Entomologist

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J. A. LINTNER, Ph. D., STATE ENTOMOLOGIST

ALBANY
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## WHAT SCALE INSECTS ARE

There is a large class of small insects — some, indeed most, of which require a magnifying glass for their observation, which are particularly detrimental to fruit-culture, yet from their inconspicuous appearance usually escape notice until discovered when search is made for the cause of the languishing condition or death of the tree or shrub infested by them. Even then it is rather difficult to believe that the true cause has been found in what often seems to be merely an unnatural roughening of the bark or a moderate incrustation formed upon the surface.

The species more commonly met with (the Diaspinæ) have received the name of *bark-lice*, from the appearance of the young as they travel over the bark for a few days after they are hatched; and of *scale-insects*, from the scale-like covering secreted by the insect and beneath which it is hidden after it has fastened itself to the bark. Scientifically, they, together with the "mealy-bugs," are known as Coccidæ. In classification they have place in that division of the Hemiptera (a large order of suctorial insects) known as Homoptera, the wings being of a uniform thickness throughout, and thereby distinguishing them from the other division (Heteroptera) in which the front wings are thickened in their basal half to a degree, often, approaching the elytra or wing-covers of beetles. It is to this last-named Division that the popular name of "bugs" has become attached. All of the Hemiptera are suctorial, and take their food through a beak or proboscis instead of by biting jaws. They differ greatly in their structure, and in modes of development; the latter, in some of the families, as in that of the Aphididæ or plant-lice, is of intense interest.

The development of the Coccidæ is quite peculiar. The females do not become perfected into winged creatures, but with age assume the form of scales or galls, or of grubs covered with wax or powder; or become degraded beneath their sheltering scale into barely more than egg-sacs, retaining only such simple organs as are essential to their life during the reproduction of their young. The male, however, undergoes a complete transformation and becomes winged, but with only a single pair of wings of very simple structure (see in Figures 3, 2 and 3 in Plates I, II and VII). It lives but a day

or two, dying speedily after the fulfilment of the purpose of its being. It takes no food, for in this stage it possesses no mouth or digestive organs.

A few species of the Coccidæ are of service to us, such as the *Coccus cacti* from which the valuable dye, cochineal, is obtained; the *Carteria lacca* which excretes the material known to us as shellac; from another species we have the commercial article known as china wax; and still another species occurring in Arabia produces a solidified honey-dew called "manna," which "is thought by some to have been the heaven-sent manna that nourished the Hebrews in their wanderings."

About 125 species of North American Coccidæ have been described, and others are being brought to notice each year, either from having been previously overlooked, or recently introduced from abroad. All of them are destructive in proportion to their rapidity of multiplication and the greater or less economic importance of the plants that they infest.

# SOME DESTRUCTIVE SCALE-INSECTS OF THE STATE OF NEW YORK

Before proceeding to the consideration of the San José scale,—the subject of this bulletin, it may be of service to refer briefly to a few other species which, although common in the State of New York, and quite harmful to the trees that they infest, are still almost wholly unknown to the fruit-grower and to others who are suffering from their presence. From the figures given of them, they may at once be distinguished from the San José scale.

## The Apple-tree Bark-louse

The most common of these is the apple-tree bark-louse, shown in Fig. 1 of Plate I, in its natural size as it occurs on the bark of trunks and limbs, often more abundantly than is represented in the cut, completely covering the bark and overlaying one another, and lending an increased diameter to the infested twig. The color of the scale is brown or ash-gray, nearly approaching that of the bark. The female scale measures about one-twelfth of an inch in length, of a long, usually more or less curved form, pointed at one end on which a magnifier may show the yellowish cast-off skin of the insect, and rounded at the other end. From its peculiar shape it has been frequently written of under the name of the oyster-shell bark-louse. It bears the scientific name of *Mytilaspis pomorum* Bouché. The male scale is of a considerably smaller size, the sides nearly straight, less rounded at the larger end, and of a brighter color. It will seldom be found associated with the females on the bark, as its natural place is on the leaves on either side, especially along the midrib (Riley). If a recent uninjured female scale be carefully lifted after oviposition — at any time during the winter — from fifty to a hundred small, oval, white eggs may be found underneath it, which would ordinarily give out the young insect about the first of June in the latitude of New York.

This destructive scale is far from being confined to the apple, but may also be found on the plum, pear, raspberry, wild gooseberry, wild cherry, red currant, sugar and swamp maples, white and black ash, birch, poplar, willows, linden, horse chestnut, elm, &c. It will be seen from the above, that it has a large number of host-plants.

## The Scurfy Bark-louse

This scale-insect, known to science, as *Chionaspis furfurus* (Fitch), is quite common in the State of New York, where, it is believed to be more numerous and more injurious than in any other of the United States. I have recently seen an orchard of the Kieffer pear, in Columbia Co., N. Y., in which the trunks, of from three to four inches in diameter, were so thickly coated with the scales that at a little distance they appeared as if they had been whitewashed.

The scale, as it appears when scattered over the bark, and the male and female scales magnified, are shown in Fig. 2 of Plate I. The young larva, the mature female, the male pupa, and the male, are represented in Figure 3 of the same Plate, which has been prepared under the supervision of Mr. L. O. Howard, of the Entomological Division at Washington, to illustrate the insect in his article on the "Scale Insects of the Orchard" shortly to appear, and kindly furnished for use in this Bulletin by consent of the Department of Agriculture in advance of its own publication.

Dr. Fitch has described so faithfully the appearance of a badly infested tree and of the scale, that his account is transcribed herewith: "The bark of the limb [pear tree] was covered with an exceedingly thin film, appearing as if it had been coated over with varnish, which had dried and cracked and was peeling off in small irregular flakes, forming a kind of scurf or dandruff on the bark. In places this pellicle was more thick and firm, and elevated into little blister-like spots of a white and waxy appearance, of a circular or broad oval form, less than the tenth of an inch in diameter, abruptly drawn out into a little point at one end, which point was stained of a pale yellowish color and commonly turned more or less to one side." This refers to the female scale, shown in enlargement at *c* of Figure 2, Plate I. The male scales, which usually congregate by themselves (enlarged at *d* in same figure), are only from one-fourth to one-third as large, narrow, usually straight, three-ribbed, and of a snowy-white color. The eggs found beneath the scales are of a purplish-red color. They hatch about the first of June.

This scale attacks the apple, pear, black cherry, choke cherry, and mountain ash. I have recently found it abundantly on the Japan

quince, *Pyrus japonica*, in Washington Park, Albany, — large plots of which were being killed by it.

### The Pine-leaf Scale-insect

This is another white scale which is quite conspicuous on the leaves of the pine and the spruce on which it occurs. It attacks mainly transplanted trees, and had not been seen by Dr. Fitch, when described by him, on those growing spontaneously in the Forests. The foliage of a large number of Austrian pines (*Pinus Austriaca*) growing in Washington Park, in Albany, a few years ago, was so thickly covered with the scales that it was literally whitened with their myriads. Hundreds could be counted on a single leaf. Nearly all of the infested trees were taken up and burned. Large numbers of the scales were eaten into and destroyed by a little lady-bug, — "the twice-stabbed lady-bird," — and to the abundant presence of this scale-eating insect, may be owing the fact that in late years the scale has been far less destructive (see *Fifth Report Insects of New York*, 1889, page 266).

The scale is represented in Fig. 1 of Plate II, in natural size upon the leaves, and much enlarged, beneath. They are of an elongate oval form, of a pure white color with a waxy lustre, and with the conspicuous yellow cast skins resting on the smaller end. Dr. Fitch, in his Second Report, 1856, has devoted a half-dozen pages to the insect and its lady-bug destroyer.

### The White Scale

A troublesome scale frequently infests conservatories and house plants, which may be recognized from the representation of infested leaves and the magnified scales shown in Fig. 2 of Plate II.

The scales are white and are sometimes so abundant as to give a whitewashed appearance to the trunks of the trees that they infest. It is known, in science, as *Aspidiotus nerii* Bouché. Its specific name of *nerii* is drawn from the botanical name of the oleander, *Nerium*, which is one of its favorite food-plants. Ivy, when grown within doors, is quite subject to its attack, and is liable to be killed by it unless care is taken to prevent the multiplication of the scale. Professor Comstock reports having studied the species on the following named plants: Acacia, magnolia, oleander, maple,

Yucca, plum, cherry, currant, English ivy, and lemons from the Mediterranean.

The scale of the female is nearly circular, flat, whitish or light gray, with the dull orange exuviæ (cast skins) central or nearly so. The ventral scale (as distinguished from the exuviæ) is a mere film applied to the bark. Diameter when full-grown, one-twelfth of an inch. The male scale is snowy-white, slightly elongated with the light yellow larval skin nearly central — diameter one-half that of the male. It is distributed over all the United States, and over much of Europe.

### The Maple-tree Scale-insect

This is one of our largest scale-insects, and, at the time of hatching of the eggs in late June and early July, is more conspicuous than any other found in this part of the United States. It is observed more frequently upon the soft maple, *Acer dasycarpum*, than elsewhere, but it is often found infesting grapevines where it is known as the grapevine bark-louse. It was described forty years ago as *Coccus innumerabilis* — (now included in the genus *Pulvinaria*) — the specific name applicable both to the myriads in which it appears in some localities and to the immense number of eggs produced by the female: often a thousand or more can be counted from underneath a single scale. Fig. 1 of Plate III illustrates the scale as it appears when attention is usually drawn to it. It is then seen as a white, cottony mass of from three- to nearly four-tenths of an inch long, about one-half so broad, of a sub-oval form, bearing upon the narrower end a brown scale darker at the margin, somewhat flattened down or bent upward near its middle to nearly a right angle, oval, broader behind, where it is notched and apparently cleft for a short distance on its middle: on the front is a medial ridge for about one-fourth or one-third its length: it usually shows five transverse wrinkles or folds and about the same number of raised lines running outwardly on each side to the hinder margin. A common appearance of the adult scale is shown at *b* of Fig. 3 of Plate III, and at *a*, *b* and *c*, immature forms in Fig. 4.

The white cotton-like mass, which is a characteristic of the genus *Pulvinaria*, is a secretion thrown out by the insect for the protection of its eggs, and also of the young insects for a short time after their hatching.

In Fig. 2 of Plate III (after Walsh and Riley) the scales and egg-masses are shown on osage-orange as *Lecanium Macluræ*, and on maple as *L. acericola*, but both now referred to *P. innumerabilis*.

This scale had become very abundant upon the maples in the streets of Brooklyn in 1890, and was reported as having killed a large number of the infested trees.* In 1884, it was excessively abundant and quite destructive over the larger part of the State of Illinois. Further particulars of it, and available remedies, may be found in the *Sixth Report on the Insects of New York*, 1890, pp. 141–147.

### The Plum-tree Scale-Insect

In Plate IV, the plum scale is shown, — an apparently new and destructive plum pest, which has during the past year made its appearance in different localities in the State of New York, particularly in its western portion. Examples of it were received by me on May 14th and 15th from Dr. Collier of the Geneva Agricultural Experiment Station, and from C. M. Hooker and W. C. Barry, of Rochester. No record could be found of its previous occurrence as infesting the plum. Upon submitting it to Prof. T. D. A. Cockerell, of Las Cruces, New Mexico, who has made special study of scale insects, it was determined by him, with a possible doubt, as *Lecanium juglandis* Bouché. This determination has not been accepted by some entomologists, while as an explanation of difference of opinion in regard to it, it has been suggested that two closely resembling species are associated on the infested trees.

The species of *Lecanium* are large, conspicuous scales, as may be seen covering the branch in the figure, approaching a half globe in form, and in the season of reproduction, containing within their capacious bodies a very large number of eggs — a thousand, or it may be two thousand or more. From their rapidity of multiplication they may prove very injurious to the trees that they infest, but fortunately their size, and their tenderness during a portion of their existence, exposes them to parasitic attack, and to destruction from certain weather conditions. They are amenable to treatment with kerosene emulsion, and to the methods which will be recommended for the destruction of the San José scale.

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* *Eighth Report on the Insects of New York*, 1893, page 177.

Prof. M. V. Slingerland, of the Cornell University Experiment Station has made a study of this insect in the plum orchards of Western New York, the results of which are published in Bulletin 83 of the Station — describing it, narrating its destructiveness, naming the few plants upon which it is believed to have passed from the plum, its life-history, its natural enemies, and approved methods for combatting it.

This scale has been found abundantly in some localities in Eastern New York: in Orange Co., it has been mistaken by some fruit-growers for the San José scale, but from their great dissimilarity in appearance, there is hardly an excuse for confounding them.

The figure representing an infested plum branch is from a photograph taken by the Geneva Experiment Station, and employed in illustrating a brief notice of the insect by Prof. S. A. Beach, in *Garden and Forest* for July 18, 1894, from which paper it has been obtained.

In the preceding brief notices of some of our more common scale insects, particular mention of the insecticides available for their destruction and methods of application, have been omitted, as those which will be indicated for use against the San José scale, will be found equally serviceable against each one of them.

## THE SAN JOSÉ SCALE

The San José Scale — from the many different fruit trees that it infests, the rapidity of its multiplication through its successive broods during the year, and the short time in which it kills the trees that it attacks — is justly regarded as one of our most pernicious scale-insects. Its character is indicated in the specific name of *perniciosus* given to it by Professor Comstock when first described by him in 1880, in the *Report of the Commissioner of Agriculture* for that year. He has written of it: "It is said to infest all the deciduous fruits grown in California, excepting peach, apricot, and the black Tartarean cherry.* It attacks the bark of the trunk and limbs as well as the leaves and fruit. I have seen many plum and apple trees upon which all the fruit was so badly infested that it was unmarketable. In other instances I have seen the bark of all of the small limbs completely covered by the scales. I think that it is the most pernicious scale-insect known in this country."

The Los Angeles (Cal.) Horticultural Commission, in their report for 1893, say of it: "This pest, if not speedily destroyed, will utterly ruin the deciduous fruit interests of this coast. It not only checks the growth of the tree, but it covers the tree literally entirely, and the fruit nearly as much so, and, if left unchecked, the tree is killed in three years' time."

### Introduction and Spread

As with the larger number of our more injurious pests, the San José scale is not native to North America. Where it originally occurred is not known. It is frequently found upon plants imported from Japan (Coquillett), and also occurs in Chile and in Australia. It is believed to have been brought into California in or about the year 1870. It first attracted the attention of fruit-growers at San José, in Southern California, in 1873. In 1882 it had extended into all the fruit-growing districts of California, and had entered Oregon and Washington. It is also found in Nevada, but when first observed there is not known. It is reported in one locality in Idaho in 1894 (Aldrich), and as well established at Las Cruces, New Mexico (Cockerell).

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* It has since been found on the peach, and apricot.

### Occurrence in Eastern United States

It was quite a surprise when not long ago the discovery was made that this destructive insect had crossed the continent and had made its appearance in the Atlantic States. Its first recognition was by Mr. L. O. Howard, of the Division of Entomology at Washington, in August, 1893. A supposed fungus disease on pear sent from Charlottesville, Va., to the Department of Agriculture and shown to Mr. Howard, was "at the first glance recognized as that scourge of western orchards, the San José scale (*Aspidiotus perniciosus* Comst.)."

### Investigations, etc., by the U. S. Department of Agriculture

During the autumn, two of the assistants of the Entomological Division, Messrs. Schwarz and Coquillett, were sent to Charlottesville, to examine and report upon the infestation. It appeared from their examinations that it was limited in extent, being almost wholly confined to a pear orchard of about a square acre in area, but that it affected pear, peach, plum, apple, currant, rose, quince, gooseberry, and raspberry, and that it had already been present there for several years. It was subsequently learned that, in all probability, it had been introduced on nursery stock purchased from a New Jersey firm. Mr. Hedges, the owner of the orchard, was of the opinion that it had been brought on currant plants purchased in New Jersey eight years previously. Mr. Schwarz reported on the situation of the infested orchard, the plants attacked, other infested places adjoining, habits of the scale, and its observed enemies. Mr. Coquillett reported upon the infested locality, and the conjectural sources of the scale. (*Insect Life*, vi, 1894, pp. 247–254.)

Early in the spring of 1894, through the coöperation of the U. S. Department of Agriculture and the Virginia State Board of Agriculture, Mr. Coquillett, who had conducted very successfully most of the experiments in California for the destruction of scale insects by inclosing the infested trees with tents and fumigating them with hydrocyanic acid gas, was entrusted with the operations for destroying the scale in Charlottesville by the same method — always effective when properly conducted. It appears in his report submitted (*loc. cit.*, pp. 324–326), that 326 trees and shrubs were

subjected to the gas treatment. Examination made a few months thereafter disclosed no living scales.

*In Maryland.*— In March, 1894, the scale was sent to the Division of Entomology on peach twigs from a large peach orchard in Riverside, Charles Co., Md. It was learned that the scale had been introduced in 1887 and 1888, on peach trees purchased of a New Jersey nursery. Many of them had died, and nearly all of those that remained were found to be thoroughly encrusted with the scale, so that at the time of examination they were being taken up and destroyed. (Other trees to which the scale had spread, had been treated by their owner during the preceding winter, apparently with good results, with the three principal winter washes, viz., strong kerosene emulsion; lime, salt, and sulphur; and resin wash.) A trunk-washing in April with strong kerosene emulsion was successful to the extent of killing 90 per cent of the scales. Several sprayings were made during the summer with different mixtures,— some of them under direction of Mr. Coquillett,— by which most of the scales were killed. At the time of Mr. Howard's report (from which most of these items relating to the eastern presence of the scale have been drawn) in August, it was thought safe to say that the insects would be completely stamped out in this locality by the close of the year.

*In Florida.*—At the same time of the discovery of the Maryland locality, the scale was also received from De Funiak Springs, Florida. At the request of the fruit-growers of that section of the State, the Department of Agriculture sent Mr. H. G. Hubbard to make examination and report. The insect was practically confined to the peach and plum, but occurred also, in small numbers on Kieffer pears, and on pecan and persimmon. Many thousands of trees were infested, and nearly every orchard within a radius of five or six miles was more or less attacked. Arrangement was made for the Experiment Station of Florida to undertake the work of destroying the scale, by going over all the infested trees in the district with five or six applications of the resin wash. If the weather should prove favorable for the use of the wash, there was reason to believe "that the nuisance will have been abated by the close of the season in Florida, although extermination [from the peculiar conditions of the infested locality] may not be found possible."

*Discovered in other States.*— In consideration of the discovery that some at least of the above-noticed infestations of this pernicious California scale, were traceable to New Jersey nurseries which were, in all probability, still serving as distributing centers for the distribution of the pest over nearly all the country, a Circular was prepared by Mr. Howard, Chief of the Division of Entomology, U. S. Dept. Agricul., describing and figuring the scale and warning fruit-growers of its exceeding dangerous character, which was distributed in the first week of April (1894) to all Eastern agricultural newspapers and to nearly 12,000 Eastern fruit-growers whose addresses were obtained from the pomologist of the department. This circular,— with its excellent illustrations*, description of its appearance, explanation of its manner of spreading, and the best remedies for it — as might naturally be expected, excited much interest and alarm. Scale insects of many kinds as well as insects belonging to other groups, were sent to the Department, with the inquiry if they were the San José scale.

As the result of the distribution of this Circular, the following additional localities were ascertained:

Neavitt and Chestertown in Maryland; Bartle, Indiana; many points in New Jersey; Atglen and Lewisburg, in S. Eastern and Central Pennsylvania. It was also received from Middletown, Idaho; and from British Columbia.

Referring to the above attacks, Mr. Howard gives encouraging reports: The orchard of 7,000 trees in Atglen, Pa., under direction of Dr. J. B. Smith, Entomologist at Rutgers College, New Jersey, had been treated three times at intervals of ten days, with kerosene emulsion, with absolute success.

At the Lewisburg locality, the few infested pear trees that had been bought from the New Jersey nurseries in 1890, had all been killed but one. Other trees to which the scale had spread were being treated by the owner with every prospect of extermination.

At Bartle, Indiana, two young apple trees from New Jersey were infested. Those were taken up and burned, and no more of the insects were discoverable by careful search. (A second infestation has since been discovered at North Madison — See *Rural New Yorker*, liv, p. 87.)

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* I am indebted to the Department for the privilege of introducing them in this paper: see Plates VI and VII.

At Neavitt, Md., a 10-acre orchard of peach trees was badly infested — nearly every tree was languishing from the attack. Many had been taken up and destroyed. Full directions were given for spraying, and the success of the operations will be watched. The source of this infestation could not be definitely ascertained, but it was thought by the owner that the first affected trees had come from a Missouri nurseryman — not from New Jersey.

Chestertown, Md., showed but few infested trees. They had been treated by the owner with thick whale-oil soap of the consistency of molasses, with every prospect of extermination of the scale. The infested trees had been received from New Jersey in 1890. As a summary of the above, Mr. Howard states that the scale had been exterminated (in 1894) in Indiana and Virginia, and the probabilities were strong of a like result before the close of the year, at the other localities named, except in Florida and New Jersey.

It has since come to the knowledge of the Division of Entomology, that the scale has been found abundantly in three new localities in Maryland. It has also been discovered in a locality in Southern Georgia; in an orchard in Southern Ohio; in Newcastle Co., Md.; in Jefferson Co., Indiana; at City Point, Va.; and at Bristol, Pa. In some of these localities the infestation was quite limited, and it is believed to have been exterminated. (L. O. Howard: Further Notes on the San José Scale, in *Insect Life*, vii, 1895, pp. 285, 286.)

### The San José Scale in New York

During the meeting of the American Association for the Advancement of Science, at Brooklyn, N. Y., in August last — in a paper read by Dr. Smith before the Association of Economic Entomologists on "The San José Scale in New Jersey," it was incidentally stated that an orchard in Columbia County, New York, was known to be badly infested with the scale. The particular orchard was not named, but later, at my request, the information was obtained from Dr. Smith, that Mr. L. L. Morrell of Kinderhook, had not long ago purchased a number of young apple trees (Ben Davis variety) from one of the New Jersey nurseries. Two years later (in 1894), on examination of these trees by one of the owners of the nursery (a relative of Mr. Morrell), they were found to be badly

infested, and advice was given that they should be at once taken up and destroyed. A week or two later it was learned from Mr. Morrell that this had been done, and it was thought that with the destruction of the entire purchase, the scale had been exterminated.

Thinking it important to know whether the measure had been entirely successful, I visited Mr. Morrell early in November, and was met with the unpleasant intelligence that he was fearful that he still had the insect with him, for he had found upon a single pear what he believed to be the scale. It proved to be such,— perhaps a half-dozen of individuals being scattered over its surface.

On examining his orchards, the scale was found abundantly in one of them — a young pear orchard in which a few trees had borne fruit, for the first, the present year. Some of the trees were moderately infested — perhaps a half-dozen scales or less being found upon them; on others the scale was so numerous as to fairly encrust the branches and most of the trunk. It was apparent that the latter were those upon which the insect had been introduced, and from which they had been scattered throughout the orchard by the agency of birds or otherwise to individual trees in various portions of it.

Most, if not all, of the stock of this orchard, had been purchased of the New Jersey nursery two years preceding the planting of that which had been taken up and destroyed — the condition of this having been overlooked at the time. A large portion of the orchard was critically gone over by me, and the trees marked which called for special care in the application of the winter wash recommended, and those which should be at once taken up and burned. The examination of the remainder of the orchard was subsequently made, and a number of infested trees discovered. So determined was Mr. Morrell to rid himself of this pest, that rather than wait for a winter treatment, all of the infested trees, as he has informed me, were taken up and burned: he believed that he did not have a scale remaining in his orchard. If it should prove that in this he has been over-confident, there is every reason to believe that within another year, the scale will be exterminated in this locality.

As the scale occurs also on the leaves — usually in rows along the midrib on the upper side, it was recommended to Mr. Morrell that the leaves from the worst infested trees which at the time of my

visit were lying on the ground beneath or near them, should be raked together and burned, in order to prevent the chance of the scales being carried by the winds over the entire orchard.*

The infested trees were entirely of the d'Anjou variety. In two other orchards of Mr. Morrell of the Kieffer pear, not a scale was found, nor on the apple, cherry, and plum trees that were examined. The infestation was apparently confined to the two purchases made at the New Jersey nursery and had not extended beyond them.

### The Scale on Long Island

In September of last year the scale was discovered in abundance in some of the nurseries on Long Island by Messrs. Sirrine & Lowe, who had been commissioned by the State Agricultural Experiment Station at Geneva for conducting some entomological investigations especially desired on Western Long Island, under an appropriation of $8,000 made by the Legislature of 1894 to the Station named, "for the purpose of agricultural experiment, investigations, instruction and information, in the Second Judicial department" of the State.

Among the earlier results of their investigations was the discovery of the San José scale in great abundance in some of the nurseries on the Island. The following notice of its first observation was communicated to *Garden and Forest*, of November 7, 1894:

The San José scale was observed first in the market at Jamaica on some Bartlett pears said to have been grown on the Island. The scale was also conspicuous on some fancy varieties of pears exhibited at the Queens County Fair; and by tracing the fruit to its source some of the infested nurseries were located. We have found the scale on Pear, Apple, Peach, and Quince stock in several nurseries.

The nurserymen were unable to give any definite information regarding the length of time that they had had the scale, but it was thought by some of them that it had been with them for the past twenty years. This, under the circumstances, is impossible: They had doubtless mistaken some other scale for it. Nor can anything definite be learned of the source of the infestation. If known to

*Dr. Smith does not believe that the fixed scale can be carried on fallen leaves. He states (*Bulletin* 106 *New Jersey Agricul. Coll. Exp. Station*, 1895, page 15): "Only such as are affixed to the tree itself have any chance of reproducing their kind. Those that fix to the leaves fall with them, and as these dry or decay the insect dies for want of food before attaining maturity."

them they have been unwilling to communicate the fact. It is stated that the stock that was infested was not grown by them, but was received from other nurseries. It would be of material service in the efforts that are being made for the extermination of the scale in the East if the localities of these "other nurseries" could be learned, but for some unknown reason it is being withheld. This unfortunate reticence is reflecting on all the other nurseries of the State of New York, for it seems to be implied that from some one or more of them the Long Island infested stock was originally received. It is conceded that its source was not the New Jersey nurseries.* The Geneva nurseries have been inspected by Mr. Lowe, with the result, it is inferred, that the scale was not found therein. The Rochester nurseries have been strongly suspected. Mr. W. C. Barry, when consulted, believed them to be entirely free from its presence, and this belief was subsequently carried to approximate certainty by examinations made by Mr. Sirrine, from which it resulted that the reported San José scale at Rochester, when examined at Washington, was found to be *Aspidiotus ancylus* — a closely resembling, but comparatively harmless species.

## Condition of the Long Island Nurseries

It would be of interest if the exact condition of the Long Island infestation could be given in this Bulletin. I can state, however, from information received from Mr. Sirrine, under date of March 22d, that he had visited the following nurseries on Long Island: — of Fred Boulon, Sea Cliff; Keene & Foulk, Flushing; Parsons & Sons, Flushing; Isaac Hicks & Sons, Westbury Station; R. P. Jeffery & Sons, Smithville South; P. H. Foster, Babylon; W. C. Wilson, Astoria; Gabriel Marc & Co., Woodside; and the Long Island Nursery Company, Brentwood.

The last six of the nine above-named nurseries were found to be free from the scale. In the worse infested of the three,— as soon as the attention of the proprietors was called to the destructive enemy that they were harboring, a large number of trees were taken up and burned. The remainder were sprayed, according to

*It has since been learned that one of the Long Island nurseries has been receiving stock nearly every year since 1888 from one or the other of the New Jersey nurseries.

directions given by Mr. Sirrine, and would be followed by other sprayings in the event of the first not proving to be entirely effectual.

In the other two nurseries, the few trees that had been found to be infested had been destroyed, and it was thought that such further work would be done before the time for shipment, that no infested stock would be sent out from them.

It was probably one of these two, that had been reported as intractable last summer. As represented at the time, the owners were indifferent to the evil pointed out to them that would result from the multiplication of the pest, and indisposed to take any measures against it. When again seen by Mr. Sirrine in March, they would give no assurance of adopting the measures deemed necessary for preventing the distribution of their infested stock. The only promise that could be obtained from them was, that "they would treat with gas the stock they sold, providing that they had the time." A promise so broadly qualified could carry no weight with it. Unless a satisfactory understanding can be had with the firm, its name, if furnished to me, will be given in a foot-note, as a protection to purchasers of Long Island stock.*

There is scarcely a doubt but that infested stock has been sent from these nurseries to many places in the State of New York. If the attempt that is being made for the extermination of the scale in the State during the present year is to prove successful, it is of the utmost importance that each locality where possibly infested trees have been delivered within the past five years (dating back to the

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*The name of this nursery has since been given me as the Parsons & Sons Company, at Flushing, Long Island. In a letter addressed them on April 8th, the following questions were asked, and the reasons stated why replies were needed: 1. Have you taken steps to learn by application to Mr. Sirrine or by other proper means, of the extent of the infestation in your nurseries? 2. Have you taken up and burned the stock that was found to be the worst infested? 3. To what extent and with what results have you sprayed with proper insecticides such other infested stock as it was not thought necessary to wholly destroy? 4. Have you arranged for treating the nursery stock sent out this season with hydrocyanic acid gas, according to the approved directions published and accessible to you? 5. Have you sent out any nursery stock this year which may have been infested without having been subjected to the gas treatment?

In the answer returned by the Parsons & Sons Company to the above-mentioned letter, the only reply to the questions proposed is that found in the following —

probable establishment of the scale on Long Island) should be ascertained, and carefully inspected as soon as possible. Request was accordingly made of the proprietors of these infested nurseries, that they would furnish the State Entomologist with a list of their New York sales from and including the year 1890 to the present. One of the firms promptly complied with the request, so far as it could be done without involving excessive labor, and sent to this office extended lists, at the same time offering to open their books for further examination and transcription by any one who might be commissioned for the purpose.

It is due to this firm — Keene & Foulk, Bloodgood Nursery, Flushing, L. I., that they be specially mentioned, and commended for the earnest manner in which they are working for the extermination of the scale in their nursery. They have asked for suggestions and directions and have promptly and faithfully carried them out — not only in burning and spraying, but also in arranging, under the best approved method, for the fumigation by the hydrocyanic acid gas treatment of all the stock that they send out this season; the latter should ensure the destruction of any scattered individual scales that may have been overlooked. They will also, upon request, replace at half-price, all such infested stock that has been received from their nursery in former years before its condition was known.

In consideration of what they have done and are doing for the protection of their customers (and at the same time, of their own interests), it is believed that orders may be more safely sent to them

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prefaced by, "We only knew last fall of the San José scale:" "He [Mr. Sirrine] has informed us now of the plants infected, and we shall take them up and burn them as soon as possible. It is our intention to destroy rather than to spray. In the plants now sending out we have not noticed any infected: it would be impossible in any event to subject to the gas treatment while in the rush of sending off trees."

Is it possible — as may be inferred from the above, that up to the middle of April, absolutely *nothing* has been done by this company toward freeing their nurseries from this dangerous insect?

In the absence of present legislation authorizing entrance upon private grounds for the destruction of the San José scale, it only remains for purchasers of trees, shrubs, etc., subject to its attack, to protect themselves so far as they may, by withholding orders from localities known to be infested and where no efficient measures have been and are being taken for its extermination.

than to other nurseries where the scale may be reasonably looked for — where no thorough inspection has been made — where it may exist without having been detected, and where no gas fumigation, as a safeguard against such a contingency, is practised.

From the two other known infested nurseries on Long Island, no notice has been taken of the request for lists of New York sales of possibly infested stock, sent them under date of Feb. 15, 1894.*

## The San José Scale in New Jersey

Nearly all of the infestation in the Atlantic and adjoining States having been clearly traceable to the sale — without knowledge or suspicion of their dangerous condition — of infested trees by two

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*The following letter was addressed to each of three nursery firms above referred to:

Gentlemen: — Will you be kind enough to favor me with a list of the addresses of all the persons in the State of New York to whom you have made sales during the last five years (1890–1894) of nursery stock which might possibly have been infested with the San José scale which you have in your nurseries.

We are expecting to get a bill through our present Legislature by means of which we shall be able to have each locality into which infested stock may have been introduced, examined by an expert, and such measures taken as give promise of exterminating the scale in our State during the present year.

If you will furnish me with the list requested, it will aid much in this undertaking.

You will also see that in consideration of the serious character of this pest and the danger of its introduction into new localities, that not until we are able to report as free from infestation, all the nurseries of the State, especially those on Long Island which have been widely published (without names), will there be a willingness on the part of fruit-growers to order stock from nurseries actually having or suspected of having, the dreaded San José scale.

One of the largest nurseries in New Jersey which had made wide distribution of the scale, has sent me a list such as I ask of you, and is doing everything in its power to prevent distribution of any infested stock.

I had asked Mr. Sirrine to procure such a list for me, but I have thought it better to make a personal request.

We must, if possible, in the interests of both fruit-grower and nurseries, as soon as it can be done, exterminate the scale from our State.

I am very desirous of being able to say in the Bulletin which is nearly ready for publication, that I have reliable assurance that no further distribution of the scale will be made from New York nurseries. The name of your nursery will not appear in it.

Very truly yours,

nurserymen in New Jersey, there will naturally be a deep anxiety to learn what has been done in New Jersey toward the prevention of further distribution of the dangerous pest, through purchases that may have been made in 1894 or to be made hereafter.

From a Bulletin entitled "The San José Scale in New Jersey" (*Bulletin* 106 *of the New Jersey Agricultural College Experiment Station*), prepared by Dr. J. B. Smith, Entomologist of the Station, and issued in January, 1895, we learn that the introduction of the scale in New Jersey occurred either in 1886 or 1887, upon a "Kelsey" plum ordered by the two nurseries under the representation of its being curculio proof, from the San José district, California. It is also known that some Idaho pear stock brought from nurseries on the Pacific Coast were also infested.

As soon as Dr. Smith became aware (in April 1894) of the existence of the scale in the State, he at once, with his accustomed energy, entered upon the task of finding the nurseries from which the infested stock had been sent, and so far as possible, the other infested localities within the limits of the State. Two large and well-known nurseries, widely separated, were soon located, and these, so far as could be ascertained, were the only distributing centers. The owners, upon being informed of the dangerous character of the pest that they were harboring, and the effect that it might have upon their business in the future, immediately took active steps for stamping out the insect upon their bearing trees, upon which it mainly occurred, and promised to prevent, through fumigation or otherwise, further shipment of infested stock. In one of the nurseries several blocks of young stock were at once torn up and burned.

The scale had been distributed from these nurseries to a number of orchards throughout the State (nearly one hundred were known to Dr. Smith), but nowhere in sufficient numbers to have spread from the orchard in which it was at first introduced. In all of these, it is believed that measures will be taken by their owners for the prevention of further spread, and toward extermination.

The work will be carefully watched, and, with our knowledge of the zeal, persistence, and ability shown by Dr. Smith in all of his operations against the noxious insects that are so unfortunate as to intrude within his jurisdiction, we have every assurance that, if extermination is possible, it will be speedily effected.

## The Two Infested New Jersey Nurseries

The interest felt among the fruit-growers of New York in the New Jersey nurseries, from which large purchases have been made each year, has been already mentioned, and will warrant a more particular reference to their present condition. Quite a satisfactory account of one, and an encouraging account of the other, can be given, based on letters from Dr. Smith, from correspondence with the proprietors of the nurseries at the suggestion of Dr. Smith, and from statements made in a recent number of the Rural New Yorker (of March 9th). The article in the R. N. Y., written by a gentleman connected with that journal, after a visit to Little Silver, N. J., to examine into charges that had been "publicly made that the Lovett Company have done practically nothing to exterminate the scale," publishes the names of "the two nurseries as those of Wm. Parry and The Lovett Company." There can, therefore, be no impropriety in the mention of their names in this Bulletin.

*The Wm. Parry Nurseries.*— The nurseries of Wm. Parry, are gladly mentioned, for the same reason given for making public the name of the nursery of Keene & Foulk, of Long Island. Unqualified praise is due Mr. Parry for his strenuous efforts for the extermination of the scale in the widely-known and far-famed "Pomona Nurseries," at Parry, and the aid so freely extended, in the endeavors being made, for its extermination wherever his extended sales may have borne it.* Promptly upon receiving a request for a list of New York sales which may have distributed the scale throughout the State, the desired list, embracing several hundreds of names, scattered through nearly every county, was sent to me, without any suggestion of compensation for the labor which it necessitated.

The expression of the confidence with which it is believed, orders could be sent at the present time to the Bloodgood Nursery, would apply in, at least, equal force to the Pomona Nurseries, where operations against the scale have been conducted largely under the direction and supervision of the New Jersey State Entomologist, Dr. J. B. Smith.

*The Lovett Company Nurseries.*— Of the condition at the Lovett Company Nurseries, the following is reported in the Rural

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* We are indebted to Mr. Parry for the detection of the scale at Kinderhook, N. Y., in the summer of 1894, as noticed on page 279.

New Yorker, *loc. cit.* Some bearing trees upon which the scale had been located last autumn by Prof. Smith, had meantime been cut down and destroyed. Satisfactory apparatus for treating the infested nursery stock was found. Upon the scale being pointed out by Prof. Smith on a considerable number of young pear and apple trees that were heeled in, and in patches here and there in rows, they were cut down as fast as found, and, finally, Mr. Lovett agreed to chop out and burn the entire block. The larger part of the nursery stock had been heeled in, after having been treated with gas. The scales upon them, according to Prof. Smith, had been "practically killed," and, if treated again before being sent out, he would consider them safe. Mr. Lovett would "guarantee to destroy every tree where Prof. Smith had found the scale, and, also, to give all these trees a second treatment with gas." The Rural New Yorker concludes its account thus: "If this is done, there will be little danger of importing the scale from this nursery. This statement refers simply to the trees now in the nursery. What has already been sent out we do not know."

Much may be inferred, and seems to be implied, in the short sentence last quoted. It is here that the Lovett Company has chosen to place itself in a position exposing it to just and severe criticism. It virtually declines to do anything toward undoing the evil which it has perpetrated — for the most part unwittingly, we believe — in the distribution of infested stock in the State of New York.

Request was made of them from this office in November, 1894, for a list of sales such as Mr. Parry had sent me — stating fully its character. After several months' delay, reply was made (Feb. 4th), declining the request upon the ground of the immense labor that it would involve, but offering to place their order books at the disposal of any persons who might be sent for their examination. As this plan did not seem feasible to Dr. Smith — after further correspondence with him, he was asked to procure, if possible, the desired list from the Company for me, for which the expenses incurred would be paid. Dr. Smith wrote them, urging compliance with my request. The letter received from the Company in answer contained the following proposition: "If he [Prof. Lintner] will send us, or you either, a remittance of $250, we will attempt to make the examination desired. * * * But we want a clear understand-

ing before we begin as to the settlement of cost of sending the list he requires." No comment on this modest proposal is needed!

The course taken by this firm has been so unaccountably strange in other respects as to expose them to suspicions which possibly may do them injustice. On the authority of Dr. Smith, the statement is made, that during last autumn [in September] in a visit of observation made them, he found that practically all of the trees in their nursery blocks were infested by the San José scale. He notified them of this fact at the time, and showed to both the President and Secretary of the company who were with him, the infested trees and the scales.

Under date of December 28th following, the Lovett Company, writing to the Director of the Ohio Agricultural Experiment Station in relation to some infested apple trees that had been sent by them to Clermont county, Ohio in 1890 — disavow all knowledge of the scale. They say: — "We would like very much indeed to have some branches from the trees referred to for examination ourselves. We have made a critical examination of our trees here in the nursery and also fruiting trees, and can find no trace whatever upon any of them of the San José scale or other scale. Having read reports upon the San José scale, we are confident that we could detect this insect if it existed upon our trees." (*Bulletin* 56, Dec. 1894, *Ohio Agr. Exper. St.*, p. 83.)

It is fortunate that since this letter was written, such pressure has been brought to bear upon the firm that it has taken the effective measures for its destruction reported in the Rural New Yorker cited, and in letters received from Dr. Smith.

As no aid is to be obtained from the company toward the examination of stock that it may have sent into the State of New York, request is herewith made of each person who within the last five years has received from the nurseries of the Lovett Company, Little Silver, N. J., fruit trees and ornamental shrubs, or other plants on which the scale is known to feed, that he will send his name to the State Entomologist, at Albany, with mention of the fact. If the arrangement proposed can be carried into effect, examinations will be made by competent persons of all such stock for the detection of the scale if present.

## The San José Scale in Ohio

It is learned from Prof. F. M. Webster, that an infested locality in Clermont County, Ohio had come to his notice in December of 1894. The scale had probably been introduced in 1891 on apple trees purchased of the Lovett Company, of Little Silver, N. J. Prof. Webster reports: "The orchard comprised about 600 trees, probably one-third of which were more or less infested — twenty-five at least so badly as to preclude all possibility of saving them, and at least double that number that could only be utilized by cutting off the trunks at a short distance above the ground and grafting them, first disinfecting the stumps. The pest had been noticed the previous year. * * * A smaller orchard set at the same time and with trees from the same nursery, was found infested to a much less extent, though the scales were badly scattered through the orchard. * * * The owners of these two orchards will take this scale in hand and stamp out the pest before it gets a stronger foothold or becomes more widely spread." (*Bull.* 56 *Ohio Agr. Exper. St.*, December, 1894.)

## Description of the Scale

The female scale, greatly enlarged is shown at Fig. 4 of Plate V and at *b* in Fig. 2 of Plate VI. It is flat, almost circular in outline, dark mottled with gray in color, with a small elevated spot at or near its center which is black or yellowish; it measures about one-sixteenth of an inch in diameter, but under some favoring conditions may attain a size of one-eighth of an inch; in its original description it is given as 0.08 of an inch.

Professor Comstock described the male scale as "black, somewhat elongated when fully formed. The larval skin is covered with secretion; its position is marked by a single nipple-like prominence which is between the center and the anterior margin of the scale. The scale of the male is more abundant than that of the female." It is often oval in shape, and of a smaller size than the female. It is represented at 5 in Plate V.

When occurring upon the bark of the twigs or leaves and in large numbers, the scales lie close to each other, frequently overlapping, and are at such times difficult to distinguish without a magnifying glass: see Fig. 1 of Plate VI. The general appearance that they

present is of a grayish, very slightly roughened scurfy deposit. The natural rich reddish color of the limbs of the peach and apple is quite obscured when these trees are thickly infested, and they then have every appearance of being coated with lime or ashes. When the scales are crushed by scraping, a yellowish oily liquid will appear, resulting from the crushing of the soft, yellow insects beneath, and this will at once indicate to one who is not familiar with their appearance, the existence of healthy living scales on the trees. (*Circular No.* 3, 2*d series*, *U. S. Dept. Agriculture*, Washington, 1893.)

As before stated, the scale is also found upon the fruit. When present, in large numbers to the extent of covering the entire surface, it interferes seriously with the proper development of the fruit, causes it to crack, often to fall from the tree, or when it remains thereon, renders it unmarketable. It is a conspicuous object from the little depression which it causes (at least late in the season) and usually a well-defined purplish ring with which each scale is surrounded of a diameter considerably larger than that of the scale (see Figure 3 on Plate V and Figure 2 on Plate VI).

## The Insect

*The male.*— As previously stated, the male only, becomes winged. It is shown greatly enlarged in Fig. 3 of Plate VII — its natural size being indicated by the crossed lines within the circle beside it. Examined under a high magnifying power its wings are seen to be transparent, each with two delicate veins only. It has a well-defined thorax and a rather large head with two large eyes. Its body is of a light amber color with dark brownish markings, and terminates in a slender "stylet" nearly as long as the body, which is the external organ of reproduction. The antennæ are long and conspicuous, ten-jointed, eight of which are hairy.

The above description of the male will be of no particular interest to others than the entomological student, as but few fruit-growers will ever see it in nature, as it is difficult to obtain and needs a good microscope for its inspection.

*The female.*— Soon after the leafing of the tree in the spring, when the young have crawled out from beneath the scales, close examination of an infested twig will show them as yellowish objects,

scarcely more than points to the unaided eye moving over the bark (Matthew Cooke has given their size as one-seventyfifth of an inch). They are of an oval form, with the normal number of legs pertaining to insects — three pairs — and a pair of antennæ. In Fig. 1 of Plate VII, giving an enlarged view of the insect from the under side, its curious long hair-like beak or proboscis which serves it for feeding and for fastening itself to the bark or leaf or fruit, is shown as curled up between the legs.

The mature female can only be seen by taking her from beneath the scale at the proper time. She then appears in a very different form from that when moving over the bark. In a subsequent molting she had lost her legs and antennæ, retaining only for her need her long and delicate proboscis consisting of four hair-like bristles within a two-jointed sheath. Fig. 2 of same Plate represents this stage of the insect, enlarged from the hair-line at the right-hand side. It is shown from the underside as seen with its transparency in nature, with a number of its young within,— this species, unlike most of the scale-insects, which produce eggs — bringing forth its young alive. Of the several segments into which the body is divided, as indicated in the figure, the last one bears groups of spinnerets, anal and vaginal openings, and upon its border, lobes, incisions, and spines (some of which are shown in enlargement at *d*): from the location, number, and form of these, important and reliable characters are drawn for the separation of the species, which may not be found in the study of the external scale alone, where they closely resemble one another.

### Its Life-History

Most of the Coccidæ are oviparous — that is, they deposit eggs underneath the scale, from which the young are soon thereafter hatched. A few are known to be viviparous, i. e., bringing forth living young, as *Aspidiotus tenebricosus* occurring on maple, and a few species of the genus *Lecanium*.* It would seem that the San José scale, *Aspidiotus perniciosus* is both oviparous and viviparous, for while generally regarded as giving out its young alive (the young shown within the body of the parent in Fig. 2 of

* As *Lecanium hesperidum*, *L. platycerii*, *L. tulipiferæ*, and two unnamed species on the red bay and on Acacia.— Riley, in *Proc. Ent. Soc. Wash.*, III, 1894, pp. 67, 69.

Plate VII), it is also recorded as producing eggs. Dr. Riley has stated of it (*loc. cit.*) — "specimens examined in December, 1879, showed that the mature females were hibernating, and that with some of them were found a few eggs and recently hatched larvæ:" on the authority of Professor Comstock (*Rept. Commis. Agricul.* for 1880, p. 305), "the eggs are white:" Matthew Cooke has written (*Inj. Ins. Orchard, Vineyard*, etc., 1883, p. 62) — "each female produces from thirty-five to fifty eggs:" W. G. Klee, State Inspector of Fruit Pests in California, states (*Bien. Rept. St. Bd. Horticul. Cal.* for 1885 and 1886, page 373) — "eggs, thirty to fifty produced by each female; color yellow; form ovate:" Mr. C. H. T. Townsend, formerly of the New Mexico Agricultural Experiment Station, states of the eggs — "According to Comstock, the eggs are white; but according to my own observation, they turn to an orange-yellow color in the spring. They hatch here about the first or second week in May" (*Bulletin No. 7 New Mexico Agr. Exper. St.*, June, 1892, p. 7). Other writers have also mentioned the eggs. As opposed to this, however,—in colonies of the scale carried over on potted pear trees in the Insectary of the Entomological Division at Washington during the winter of 1893–4, although watched with care and subjected to daily observation,—in no instance were eggs seen (*Insect Life*, vii, p. 287).

Early in June, ordinarily, in New York and New Jersey, the young escape from underneath the scale, and for a short time may be seen traveling actively over the branches, when they fasten themselves to the bark and commence to secrete a scale. They are not all given out at the same time, even the members of the same family. How long the hibernating female continues to reproduce, is not known. It is thought by Dr. Smith that it may extend over the greater part of the summer, and until "their grand-daughters are already full-grown with nearly full-grown progeny: there may be, therefore, upon a plant at one time, young born of as many as three or even four distinct generations." Certain it is that examination of an infested orchard will show the presence of the young traveling insects at any one time from early June until nearly the last of autumn. On some pieces of twigs cut in Mr. Morrell's orchard on November 1st, the little yellow young were seen in motion two days thereafter in my office. It is probable that the

young will not survive on a twig cut from the tree, for more than four or five days.

Observations made on isolated individuals at Washington showed that "the newly-hatched larvæ after crawling about for a few hours, settle down and commence at once to form a scale, which is white and fibrous. In two days the insect becomes invisible, being covered with a pale, grayish-yellow shield with a projecting white nipple at the center. * * * * * Twelve days after hatching, the first skin is cast. * * * * * In twenty to twenty-one days after hatching, the females cast their second skin. At 24 days the males begin to issue. * * * * * At 30 days the females are about full grown, and embryonic young can be seen within their bodies; and at from 33 to 40 days the larvæ begin to make their appearance." For additional observations on the development of other broods, see Howard, *Insect Life*, vii, pp. 288, 289.

From the first brood hatching early in June, a second is undoubtedly disclosed in July. How many follow, has not been ascertained. Matthew Cooke has placed the number during the season, at three,— the first in June, the second in July, and the third in October; but it would seem that the high temperature of summer could hardly fail of developing at least one additional brood intermediate to those of July and October. Four broods were developed at Washington from over-wintered females, and it was thought that there were ordinarily five. They soon became so inextricably mixed that the only importance that could attach to a determination of their number, would be as indicating the rapidity of increase of the insect in different localities and under different seasonal conditions.

The females continue to feed until prevented by the dormancy of the tree in the late autumn. It is thought that most of them pass the winter in about a half-grown stage, and resume their feeding in early spring, as soon as practicable for their entrance upon active life, in June as above stated.

### Its Food-plants

In addition to the food-plants of the San José scale that have been mentioned in the preceding pages, several others have

recently been reported to me by Mr. Sirrine, as observed by him on Long Island.

The following is the list as it now stands. It will doubtless be largely extended by future observations:

*Tiliaceæ*

Linden (*Tilia*).

*Celastraceæ*

Euonymus.

*Leguminosæ*

Acacia.

*Rosaceæ*

Almond.
Peach.
Apricot.
Plum.
Cherry.
Spiræa.
Raspberry.
Rose.
Hawthorn (*Cratægus*).
Cotoneaster.
Pear.
Apple.
Quince.
Flowering Quince.

*Saxifragaceæ*

Gooseberry.
Currant.
Flowering Currant.

*Ebenaceæ*

Persimmon (*Diospyros*).

*Urticaceæ*

Elm.
Osage Orange

*Juglandaceæ*

English Walnut.
Pecan Nut.

*Betulaceæ*

Alder? (*Alnus*).

*Salicaceæ*

Weeping Willow.
Laurel-leaved Willow (from Asia).

It will be seen from the above that the scale is recorded as occurring on plants in ten of the Orders, although one-half of the food-plants named belong to the Order of *Rosaceæ*.

## Spread of the Insect

The natural spread of this scale is not a rapid one. As the female is unprovided with wings, and is unable to change its position after having become fixed and throughout its entire period of reproduction, the insect can only pass from one tree to another during the few hours that it continues in its active larval stage. Although a rather rapid traveler its range of locomotion would hardly ever carry it to neighboring trees in an orchard, unless the branches should

interlock, in which case every facility is afforded it for spreading the infestation,— almost equal to that existing in nurseries where the young trees are grown so closely together as to form compact masses.

*Carried by birds, etc.*— It has been found that the young insect may be distributed through the agency of other insects and of birds. When abounding on a tree to the extent that much of the bark is already occupied by the scales, they apparently show a disposition to leave the tree and fasten upon any visiting insect or to the legs of birds. If this is instinctive or in accordance with a purpose, they will leave their hosts as soon as transported to a favorable place for the establishment of a new colony. It is stated that several of the young have been seen upon the wing-covers of a single lady-bird,— that they are often found on ants, and that they show a preference for insects of dark color.

*Distribution in Nursery Stock.*— The ease with which many of our most serious insect pests may be widely distributed through sales of nursery stock, has been brought to notice so frequently in recent years by studies made of the means by which injurious insects have suddenly made their appearance in new localities, that our economic entomologists have deemed it their duty from time to time to warn fruit-growers of the danger to which they are exposed, and to press upon them the great importance of a thorough inspection of all the nursery stock purchased by them. Each of the recent occurrences of the San José scale in the Eastern States, has been traced directly, or with a strong probability, to nursery infestation as its source. Of course, the danger of such introduction is the greater when the insect is so inconspicuous as is this scale, or when it is entirely hidden within its burrows in the branches or trunk, as in the case of the flat-headed pear tree borer, *Agrilus sinuatus* Oliv., lately discovered in New Jersey orchards by Dr. Smith, and by him traced to a New Jersey nursery which it was supposed had imported it from Europe about ten years ago.

### Protection from Infested Stock

In view of this danger, the following suggestion made by Dr. Smith (*Entomological News*, v, p. 311) is both timely and important: "No farmer should set out a tree until he has examined it closely and made certain that no scale-insects infest any portion of

it. He should also wash at least the trunk and larger branches with a kerosene emulsion, diluted by no more than five parts of water; and he should, finally, trim back to the smallest possible amount of wood, burning or otherwise destroying all the cuttings," thereby facilitating the growth of the tree, and disposing of the eggs of the Aphides or plant-lice and of mites occurring on the smaller twigs.

Dr. Smith also offers the following: — "Purchasers of nursery stock could insist on a written guarantee with each lot of stock purchased, that they are clean and free from insect pests, and had not been, in the nursery, affected by any plant disease, nor grown in the vicinity of diseased trees".

It is not probable that the New Jersey or Long Island nurserymen would give such a guarantee, nor does it seem that they could safely do so. Were they, one and all, skilled entomologists they might, even then, with reason, decline to commit themselves so broadly,— covering insects of all kinds, both exposed to view and hidden from the eye. But for the present, at least, while the scale infestation of these localities is so generally known, some assurance of protection will be demanded by all to whom the knowledge has come, before further orders are sent to the nurseries involved.

The following form of certificate is offered to the consideration of purchasers and nurserymen, in the belief that it would prove equally beneficial to each party. Without it, or something to the same effect, there is reason to believe, from action about to be taken in another State, that some of the unfortunate nurseries may suffer for a time from a "boycott". Let it be understood — there is no disposition on the part of any entomologist to magnify the danger to important interests from this newly introduced pest, but simply to accept it at its full magnitude: —

I do hereby certify that the stock sent out herewith has been examined by a competent entomologist, and has been pronounced by him, to the best of his knowledge and belief, to be free from living San José scales (*Aspidiotus perniciosus*); and in the event of its being shown that the stock now sent has carried with it the living insects, I do hereby agree to replace it free of cost with uninfested stock.

## Proposed Legislation

No legislation has been had in the State of New York against insect pests. Laws of this character, more or less broad and stringent, have

been passed in ten of the States, viz., California, Colorado, Idaho, Kansas, Massachusetts, Minnesota, Missouri, Nebraska, Oregon, and Washington. A compilation of these Laws, which will be found convenient for examination and as aids to future legislation, has recently been made in a pamphlet of 46 pages by Mr. L. O. Howard, and issued as *Bulletin No. 33 of the U. S. Department of Agriculture — Division of Entomology.* California, it appears, has taken the lead in resorting to legislation, moved thereto by the urgency of preventing the introduction of species known to be destructive to fruit culture in other parts of the country and from the Old World.

Although the State of New York is subjected each year to losses from insect injuries which would aggregate in amount to several millions of dollars — a large proportion of which is preventable,— no effort has hitherto been made toward the removal of so onerous a burden through a resort to legislative aid. An investigation of the insect pests of the State which was commenced forty years ago and continued, with a short interval, up to the present, has given to the people of the State details of the life-histories and habits of all of our more noxious insects, accompanied with methods for their control. These studies are accessible in State reports to all who may desire to consult them. Their recommendations are conceded to be of great value, and if the information they contain be utilized to the extent that it should be, the occasion will seldom arise when aid from legislation is needed.

There may be, however, insect infestation in some other State or country of such a pronounced dangerous character, that its introduction should be guarded against by quarantine laws. Or, an insect may have multiplied to such an extent that its control is entirely beyond individual effort, as in the case of the gypsy moth in Massachusetts. Again, a newly introduced insect pest, known only in a single locality but threatening an almost unlimited range, may call for its extermination while the task is simple and inexpensive.* Still another instance, is that of the presence of the San José scale in the State of New York. There is reason to fear that it has been sent in every county of the State. In how many orchards it has found place can not be known, with-

*Such an opportunity was lost when the pear-midge was confined to a few orchards in the town of Meriden, Conn.

out special examination of suspected localities by a person competent to identify it. Its dangerous character demands its extermination if it can be accomplished. Although it has had a foothold in the State for, probably, five years or more, it is believed that its extermination is practicable if the proper effort can be made at once, under the provisions of a bill which has been drawn up and introduced in the present Legislature — reading as follows:

AN ACT to provide for the Extermination of the San José Scale in the State of New York.

*The People of the State of New York, represented in Senate and Assembly, do enact as follows:*

SECTION 1. Whenever the state entomologist may have knowledge of the existence of the San José scale, or has reason to believe in the probability of its existence in any locality within the State of New York on any trees, plants, vines, or fruit, he shall notify the commissioner of agriculture, who shall thereupon appoint one or more experts who shall be sufficiently familiar with the scale to be able to recognize it, for the prompt inspection of the infested or suspected locality.

§ 2. Such agent shall make thorough inspection of the locality named, and if the existence of the scale is found therein, he shall notify the owner or owners of the orchard, nursery, or grounds in which the insect is found, of its existence therein, and serve a notice containing a statement of all the facts found to exist, upon the owner or owners, with an order that within ten days they shall take such measures as have been proven to be effectual in the destruction of the scale and for prevention of its further distribution, and to continue them until its extermination has been effected.

§ 3. If the owner or owners shall refuse to comply with the order of the agent, as above stated, the agent shall be charged with its execution, and for this purpose, shall employ all necessary assistance; and such agent or his employes may enter upon any or all premises within the town or city for the purpose of the speedy extermination of the scale. Such agent shall be entitled to compensation for his services under this act at the rate of five dollars for each full day spent by him in the discharge of his duties, and the necessary disbursements paid or incurred by him therein.

§ 4. The sum of five thousand dollars, or so much thereof as may be necessary, is hereby appropriated out of the state treasury to carry out the provisions of this act.

§ 5. This act shall take effect immediately.

### REMEDIES

There is no difficulty in killing this insect at any time and in any form of its existence, if the proper remedies are used and properly

applied: but if entire success is demanded — that is, if all of the insects infesting an orchard are to be destroyed, which means extermination,— so far as our present knowledge extends, it can only be accomplished in the winter season. During the many years of its existence in California the experiments there conducted, showed that several of the insecticidal applications tested, were entirely effective — particularly some of the "winter washes" of which the formulas have been frequently published. When it became necessary to contend with the insect in its eastern invasion, it was naturally supposed that the Californian remedies would be equally effective here, but experiments with them proved that they only sufficed to destroy a certain percentage of the hibernating form; and even when used in double strength, a large proportion of the scales was not destroyed. These unexpected results may probably be accounted for by a more perfect dormancy of the insects in the East than in California.

*Winter washes.*— The experiments that have been conducted under the direction of L. O. Howard, Chief of the Entomological Bureau at Washington, during the past year (1894), have been so varied and apparently so thorough that it would seem that the results attained might be accepted, without further experimentation, for future guidance in our operations against this scale. During the latter part of the year, twenty-nine different washes were tested by experienced entomologists from the Bureau, upon badly infested trees in Charles county, Maryland. In summing up these results, Mr. Howard has stated: "The only perfect results which have been reached have come from the application of two pounds or more of commercial whale-oil soap to a gallon of water, and from the application of a resin wash of six times the normal summer strength. The effects following the application of these washes leave nothing to be desired. In all cases the most careful search over the sprayed trees has failed to show a single living scale."

Unfortunately, both of the above-named washes are somewhat expensive, as the lowest price at which the whale-oil soap can be purchased is four cents the pound by the barrel, making the wash to cost eight cents per gallon. The resin wash is still more expensive. When large orchards are to be treated, the cost is quite an item, but the intelligent fruit-grower will not hesitate when con-

vinced that the choice lies between the expense of the wash and the loss of the trees.

The above are known as "winter washes," since they may only be used without serious injury to the tree during its winter dormancy. Later, it would not be safe to apply them unless in a considerably diluted form, when they would only suffice to destroy a portion of the scales.

*Home-made whale-oil soap.*— For those who would prefer making the soap for themselves, at a less cost than if purchased by the small quantity in market, Mr. Howard has given the following formula: — Potash lye, one pound; fish oil, three pints; soft water, two gallons; dissolve the lye in water and add the oil on bringing the mixture to a boil; boil for about two hours and then add sufficient water to make up for the evaporation. This will make about twenty pounds of soft soap — equivalent to about five pounds of the hard.

*The winter resin wash.*— The composition and proportions given for this, are as follows: — Resin, 120 pounds; caustic soda, 30 pounds; fish oil, 15 pints; water sufficient to make 100 gallons. The resin and soda are broken up and, together with the fish oil are placed in a large kettle, sufficient water being added to cover them. The whole is then boiled for several hours, or "until the compound will mix properly in water without breaking up into yellowish flakes." (*Insect Life*, vii, p. 293).

*Potash wash.*— Dr. Smith, in his experiments with the scale in New Jersey, has tested to his entire satisfaction the efficacy of a saturated solution of crude or commercial potash, i. e., potash in a sufficient quantity of water to dissolve it, to be used upon trees during their dormancy in the winter season, only. It may be applied either by means of a cloth or stiff brush, or by thorough spraying. The potash eats into or corrodes the scales and kills a large proportion of the insects beneath them. A month later, by which time the scales will have become riddled or loosened, it should be followed with kerosene emulsion made after the usual formula and diluted to a strength of one part to five parts of water. If these applications are thoroughly made,— according to Dr. Smith, "not a single insect need escape."

Before using any of the above washes, it is recommended to cut

back as freely as may be properly done, the infested trees, and burn the cuttings, as a large part of the scales are to be found on the terminal twigs.

*Summer washes.*— Experiments thus far made with applications that may be safely used during the summer, have failed to give a wash that will destroy all the scales — a small percentage will escape. The two that have given the best results are the summer resin wash and an ordinary diluted kerosene emulsion. With either of these, "by three applications at intervals through the summer, the insects may be kept from increasing to any serious extent." The unattached insects and those in which the scale is in its incipiency will readily be killed, and if it were possible to reach all of them the entire destruction of the insect would be effected. But this is impracticable. The young are hatching continually during nearly five months of the year, and are to be found at any time during this period in their active stage upon the tree. The number of sprayings that would be required to reach the young before they are protected by their scale, would render this method altogether too laborious and costly to depend upon it for extermination.

*Gas treatment.*— The treatment of infested trees with hydrocyanic acid gas, generated within a canvas tent made air-tight through the application of boiled linseed oil, and fastened closely down over the tree to be treated, has been extensively used in California and with entire success against some of the scale-insects of the Western Coast. The cost of the tents and the labor involved in their management, render it altogether too expensive for general use; and further,— although it has been hitherto claimed that the gas applied in this manner was absolutely fatal to all animal life, yet, late experiments appear to show that it may not be entirely depended upon for the complete destruction of the San José scale when infesting orchards. According to Mr. Howard, an orchard in Charlottesville, Va., which had been treated with the gas in March last, under the skilled supervision of Mr. Coquillett,— although "the operation was as thorough as it could be made, a few of the insects survived the treatment, as was shown by the receipt of living specimens late in the fall from Dr. Hedges." (*Insect Life*, vii, p. 286.)*

* Mr. Howard has since made personal examination of this orchard, and has found the gas treatment inefficacious. The trees are again badly infested, while one result of the fumigating has been to seriously injure the trees by causing the blackening and cracking of the bark.

*Treatment of Nursery Stock.*— It is believed that the hydrocyanic acid gas treatment is reliable for disinfesting nursery stock of infested nurseries previous to its distribution. Of course, all such stock found to have the scale in abundance, should be promptly taken up and burned, but where the scale is sparsely present or even where there is barely a suspicion of its presence, it should, before shipment be subjected to the gas fumigation. This is now being done in New Jersey and Long Island nurseries — in some of them at least, and should be made a condition upon which any further orders may be given or stock received from either of the infested districts or others that may hereafter be discovered.

The manner of treatment is the following: An air-tight box is made of suitable size for the reception of as much stock as may be conveniently treated at one time. The stock is placed therein and subjected for an hour to the gas generated in it by the combination of three ounces of water, a little more than one fluid ounce of commercial sulphuric acid, and one ounce of 60 per cent cyanide of potassium, to be placed in a glazed earthenware vessel of the capacity of at least a gallon, in the order above named: these amounts are for 150 cubic feet of space. It should be remembered that this gas should not be breathed as it is exceedingly poisonous.

## Bibliography

The following references to publications upon *Aspidiotus perniciosus* are given as an aid to those who may wish to learn more minutely of the life-history and habits of the insect, or for information upon topics which have been omitted from this Bulletin in order not to extend it to an undue length, as for example: the parasites of the insect (see *Insect Life*, vii, pp. 289–292); the possibility of the limitation of its multiplication in its northeastern range to certain portions of the State of New York and the Eastern States (*id.*, p. 292); its possible introduction through infested Californian fruit (see *Bull.* 106 *New Jersey Agr. Coll. Exper. St.*, p. 17, *and Insect Life*, vii, p. 167); the varieties of plums and pears more liable to its attack (*Bull.* 106 — *ante*, p. 16); and its natural enemies (*id.*, p. 16).

Comstock: in Rept. Commis. Agr. for 1880, pp. 304–5, pl. 12, f. 7 (original description).

Cooke: Treat. Ins. Inj. Fruit and Fruit-trees, 1881, pp. 33–4 (description, etc.); in Rept. Commis. Agr. for 1882, pp. 65, 208 (coal-oil and lye remedies); Ins. Inj. Orch.-Vine., 1883, pp. 60–63, figs. 15–21.

Chapin: in Rept. Commis. Agr. for 1882, p. 207–8 (concentrated lye remedy); in Rept. St. Commis. Fruit Pests, in Rept. Cal. St. Bd. Horticul. for 1884, pp. 34, 35, 42.

Klee: in Rept. Cal. St. Bd. Horticul. for 1885–'86, 1887, pp. 373–375, pl. 1 (habits and remedies).

Riley–Howard: in Insect Life, iii, 1891, p. 63 (in Walla Walla, Washington), p. 487 (*Aphelinus* parasite); in id., iv, 1892, p. 83 (resin wash); in id., v, 1893, p. 53 (killed by *Chilocorus*), p. 128 (killed by *Scymnus*), p. 214 (recorded in Australia), p. 280 (California remedy); in id., vi, 1894, p. 286 (in the East), pp. 360–369, figs. 26–29 (general account).

Gregorson: in Insect Life, iii, 1891, p. 169 (in California).

Coquillett: in Bull. 23 U. S. Dept. Agr.—Div. Ent., 1891, pp. 26, 27, 28 (gas and resin wash treatment); in Bull. 26 ditto, 1892, pp. 21–25 (food-plants, parasites, remedies); in Insect Life, v, p. 251 (imported parasites); in id., vi, 1894, pp. 324–326 (operations in Virginia).

Craw: in Rept. Cal. St. Bd. Horticul. for 1891, 1892, p. 285 (remedies and parasites). Le Long: in id., pp. 196, 198, 199 (remedies).

Olliff: in New So. Wales Agr. Gaz. for Sept. 1892, pp. 698, 699 (on pear in N. S. W.).

Townsend: in Bull. 7 New Mex. Agr. Exp. St., June, 1892, pp. 6, 7 (in Las Cruces).

Riley: in Rept. Sect. Agr. for 1891, 1892, p. 244 (washes used in California); in id. for 1893, 1894, pp. 215–221, pl. 1, f. 1 (general account); in Proc. Amer. Assoc. Adv. Sci., xlii, 1893, p. 229 (discovered in Virginia).

Howard: Circular No. 3, 2d Ser. U. S. Dept. Agr.—Div. Ent., April, 1893, 10 pp, 5 figs. (its Eastern appearance and remedies); in Insect Life, vii, 1894, pp. 153–163 (Eastern occurrence); in Canad. Entomol., xxvi, 1894, p. 355 (its distribution); in Insect Life, vii, 1895, pp. 283–295 (life-history, spread, parasites, remedies).

Cockerell: in Canad. Entomol., xxvi, Feb. 1894, p. 32 (No. 73 in list of Nearctic Coccidæ).

SMITH: in Entomolog. News, v, 1894, pp. 182–184 (Eastern occurrence), p. 312 (discovered on Long Island); in Insect Life, vii, 1894, pp. 163–167 (in New Jersey); in Gard.-Forest, vii, 1894, p. 344 (danger from infested California fruit); Bull. No. 106 N. J. Agr. Coll. Exp. St., Nov. 22, 1894, 1895. 24 pp. 5 figs. (in New Jersey, and general account); in Entomolog. News, vi, 1895, pp. 153–157 (operations against, in New Jersey nurseries).

KOEBELE: in Insect Life, vi, 1894, p. 27 (Orcus parasites).

SCHWARZ: in Insect Life, vi, 1894, pp. 247–252 (in Charlottesville, Va.).

LINTNER: in Rur. New Yorker, liii, 1894, p. 791 (neglected on Long Island); in Albany Eve. Journ., Nov. 7, 1894 (observed at Kinderhook, N. Y.).

SIRRINE: in Gard.-Forest, vii, 1894, p. 449 (on Long Island).

FLETCHER: in Evidence bef. Commit. Agr., 1894, p. 19 (in British Columbia); in 24th Ann. Rept. Ent. Soc. Ont., 1895, pp. 73–76, f. 48 (in Br. Columbia, habits, remedies).

SLINGERLAND: in Rur. New Yorker, liv, 1895, p. 5 (Eastern localities and prospects).

WEBSTER: Bull. 56 Ohio Agr. Exp. St. for December, 1894, 1895, 18 pp. 5 figs. (in Ohio, and N. J. Bull. 106 quoted).

H. W. C[OLLINGWOOD]: in Rur. New Yorker, liv, 1895, p. 167 (observations at Lovett Company nurseries), p. 317 (the Parsons Company nursery on Long Island).

## Explanation of Plate I.

**Fig. 1.**— The apple-tree bark-louse, *Mytilaspis pomorum* (Bouché), on apple bark. (After Comstock.)

**Fig. 2.**— The scurfy bark-louse, *Chionaspis furfurus* (Fitch): *a*, the female scales, and *b*, the male scales, in natural size on twigs; *c*, the female scale, enlarged; *d*, the male scale, enlarged. (From the Division of Entomology, U. S. Dept. Agr. at Washington.)

**Fig. 3.**— The scurfy bark-louse: [*a*], the male; *c*, the young larva; *f*, the male pupa; *g*, the female, from beneath — all enlarged; *b*, *d*, *e*, *h*, structural details of legs and antenna, in greater enlargement. (From the Division of Entomology, Washington, D. C.)

# Plate I.



Fig. 1.

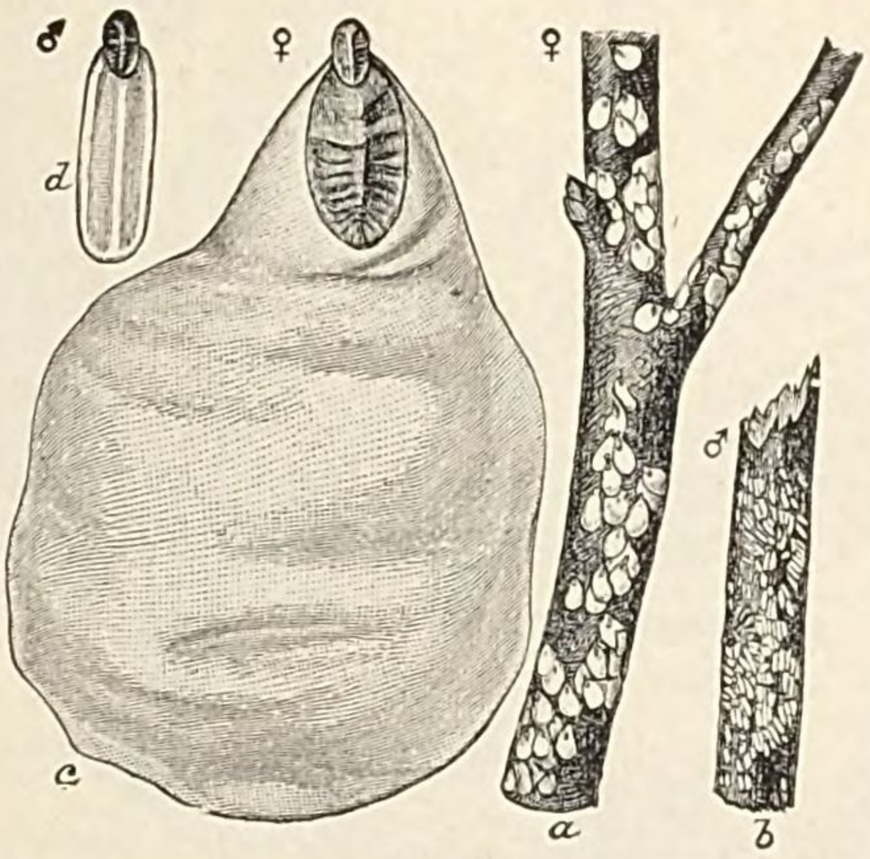



Fig. 2.

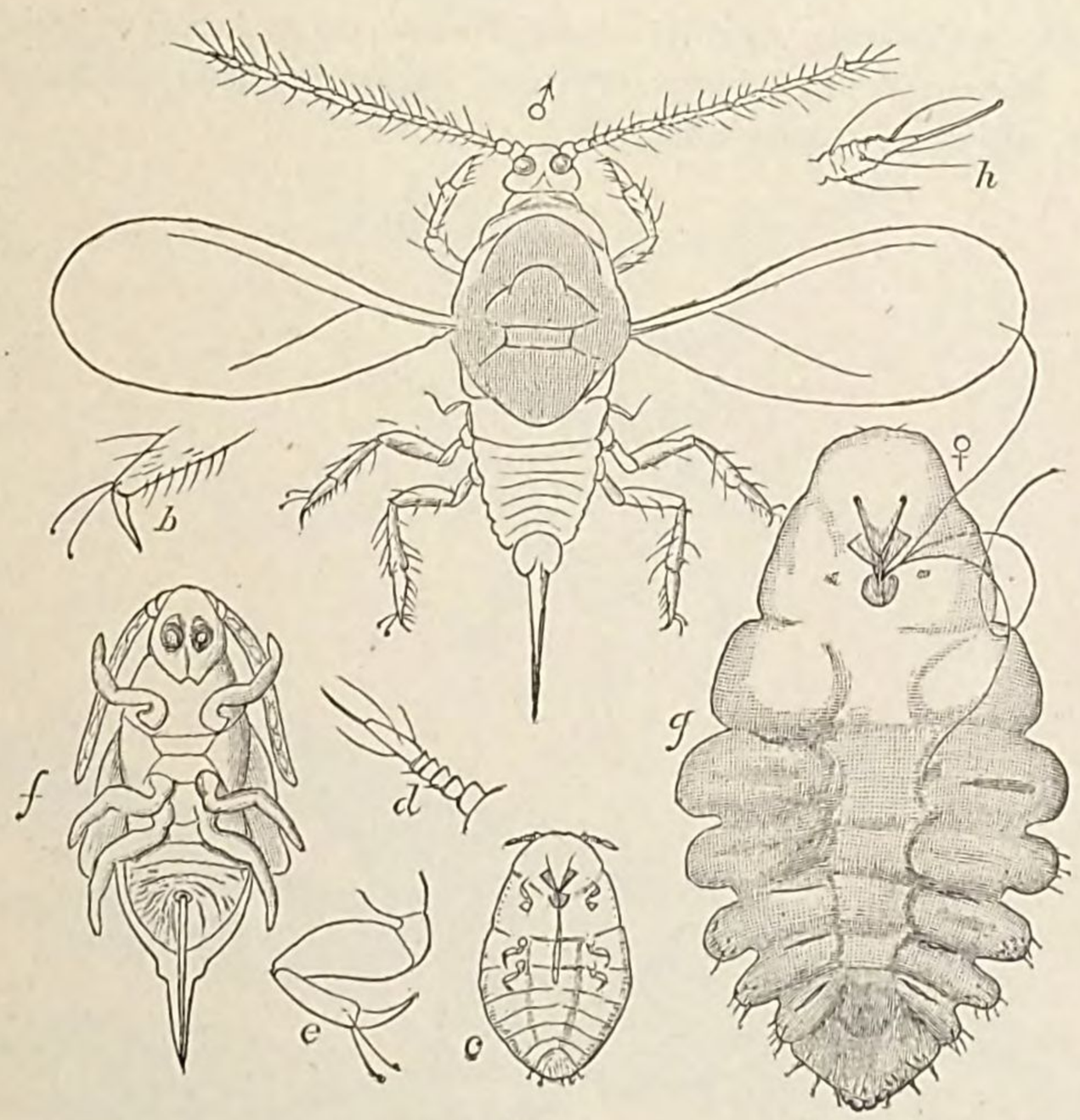



Fig. 3.

## Explanation of Plate II.

**Fig. 1.**—The pine-leaf scale-insect, *Chionaspis pinifolii* (Fitch): *2*, the scales on the leaves in natural size: *a*, leaves not stunted by the presence of the scales; *b*, scale of female of usual form, enlarged; *c*, wide form of the same, enlarged; *d*, a male scale enlarged. (After Comstock.)

**Fig. 2.**—The white scale, *Aspidiotus nerii* Bouché, on an Acacia twig, in natural size: *a*, the male insect, enlarged; *b* and *c*, the male and female scales, enlarged. (After Comstock.)

# Plate II.

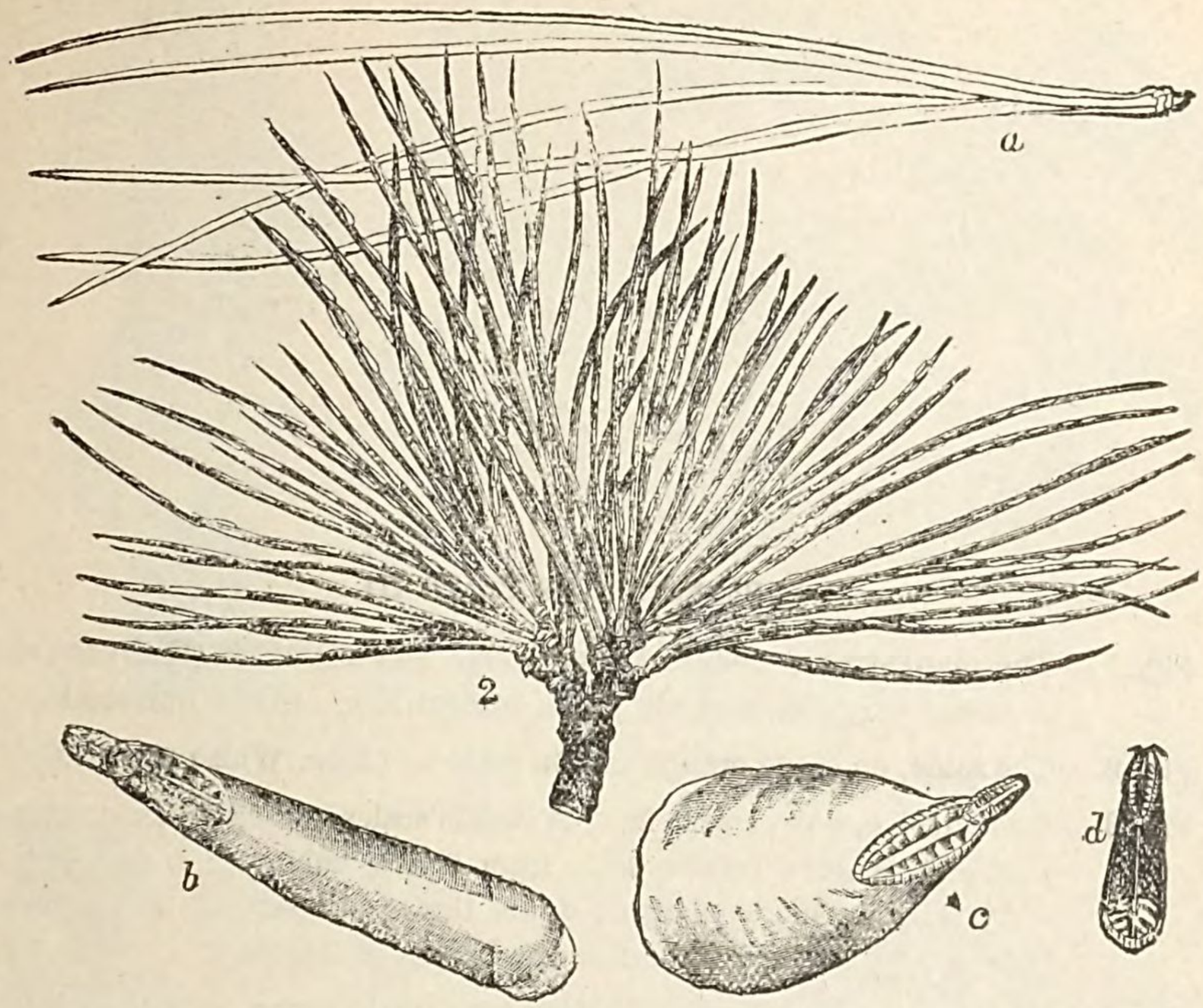



Fig. 1.

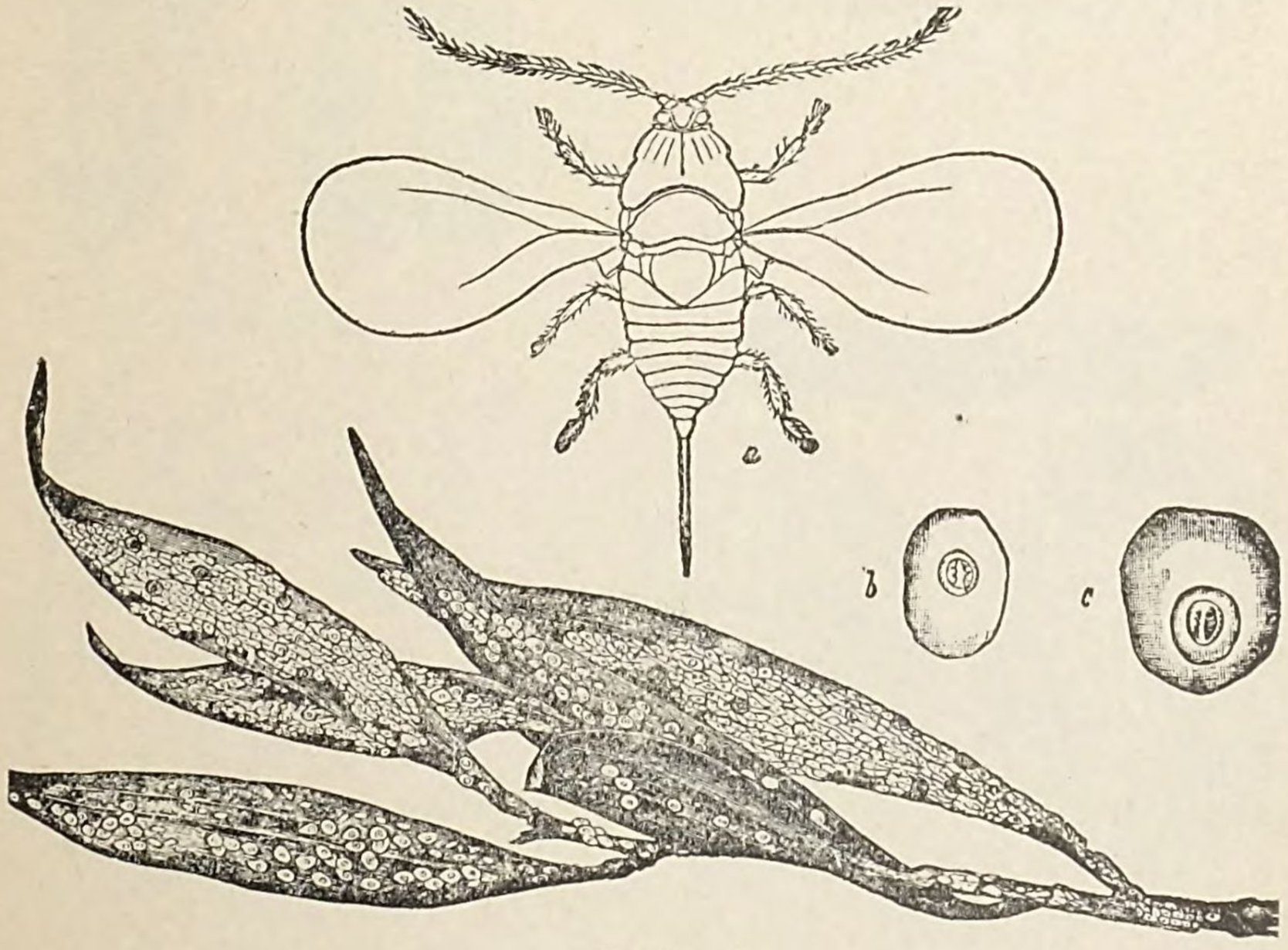



Fig 2.

## Explanation of Plate III.

**Fig. 1.**—The maple-tree scale-insect, *Pulvinaria innumerabilis* (Rathvon), with extruded egg-masses, on grape, natural size. (After Comstock.)

**Fig. 2.**—The same, on osage orange and on maple. (After Walsh and Riley.)

**Fig. 3.**—The same: *a*, a twig with mature female scales and egg-masses, natural size; *b*, mature female scale from above, enlarged; *c*, female scale from below, more enlarged; *d*, the thread-like setæ of the proboscis. (From the Seventh Report on the Insects of Illinois.)

**Fig. 4.**—The same: *a*, a twig with half-grown female scales, in natural size; *b*, autumnal female scale from above, enlarged; *c*, the same from beneath; *d*, the male insect enlarged. (From the Seventh and Thirteenth Illinois Reports.)

# Plate III.



Fig 1.

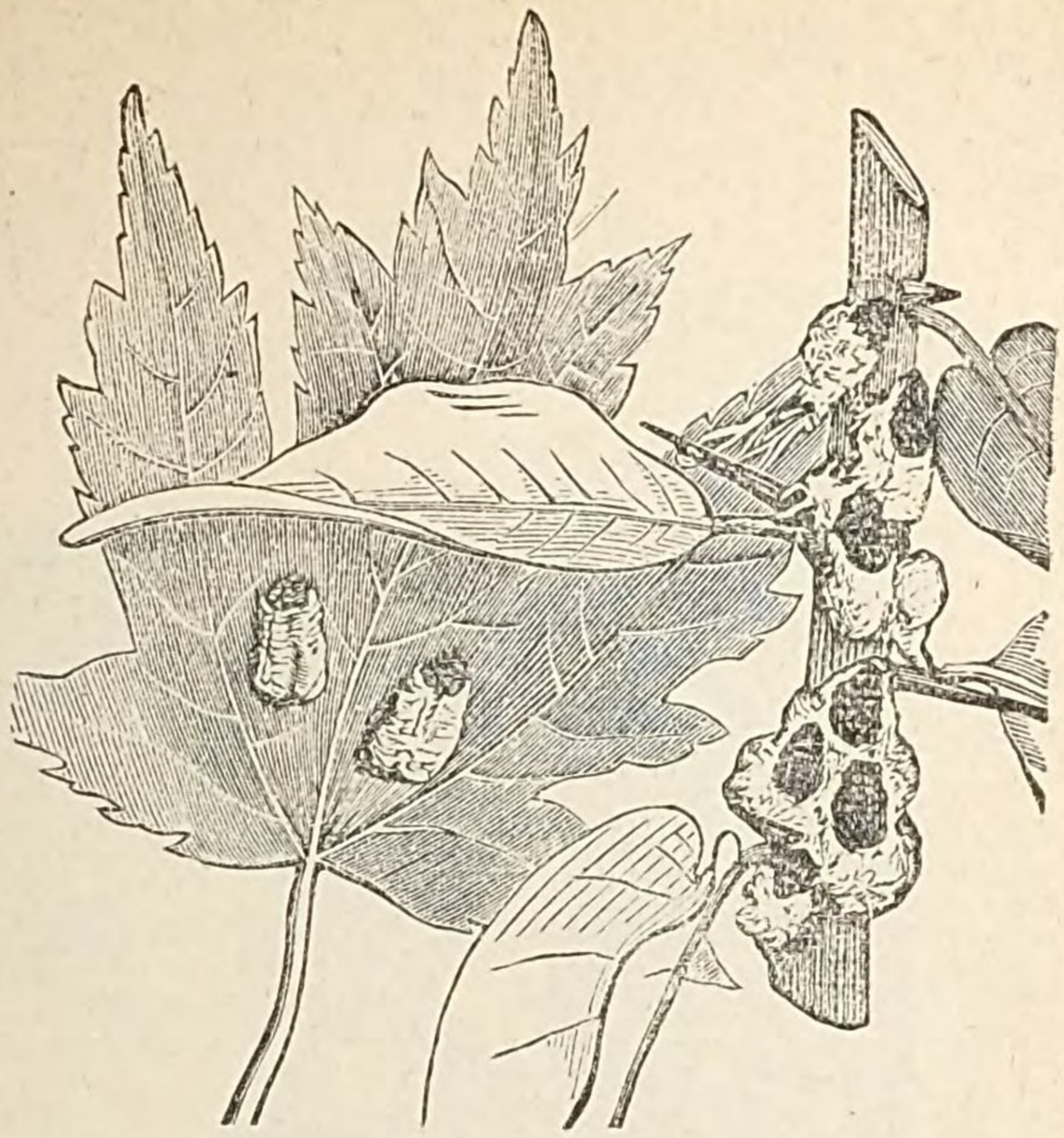
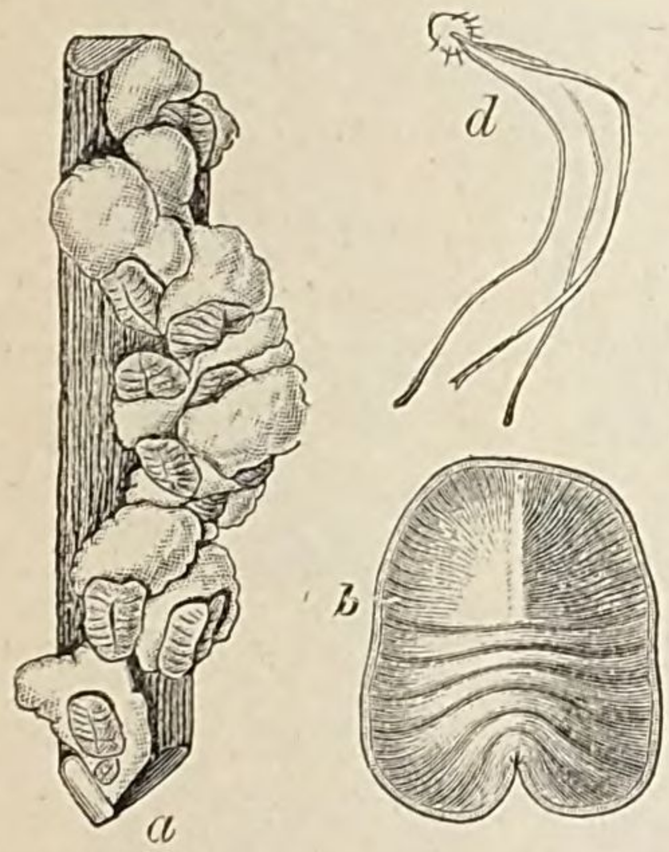
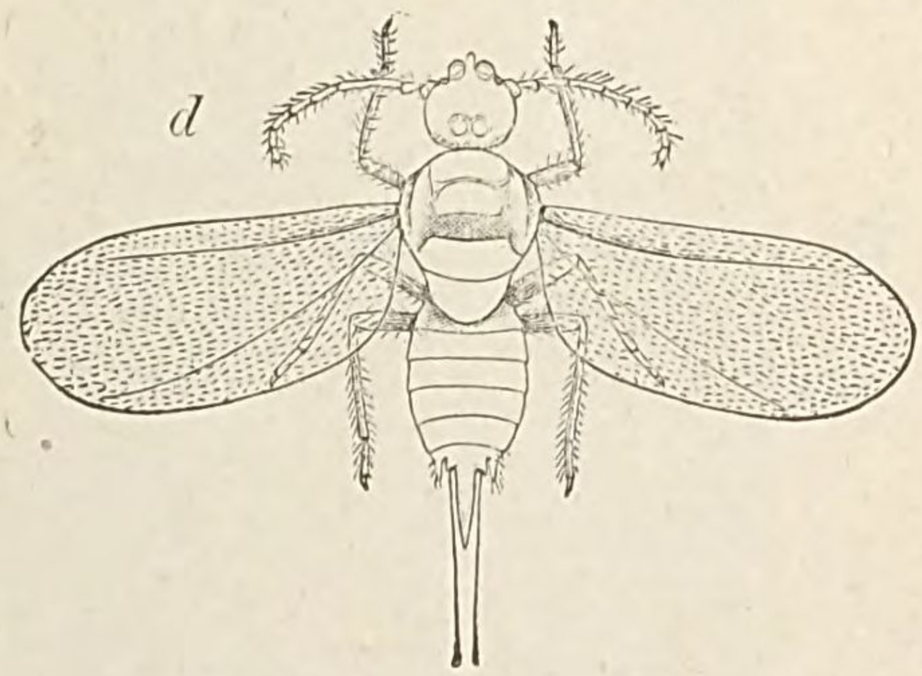


Fig. 2.



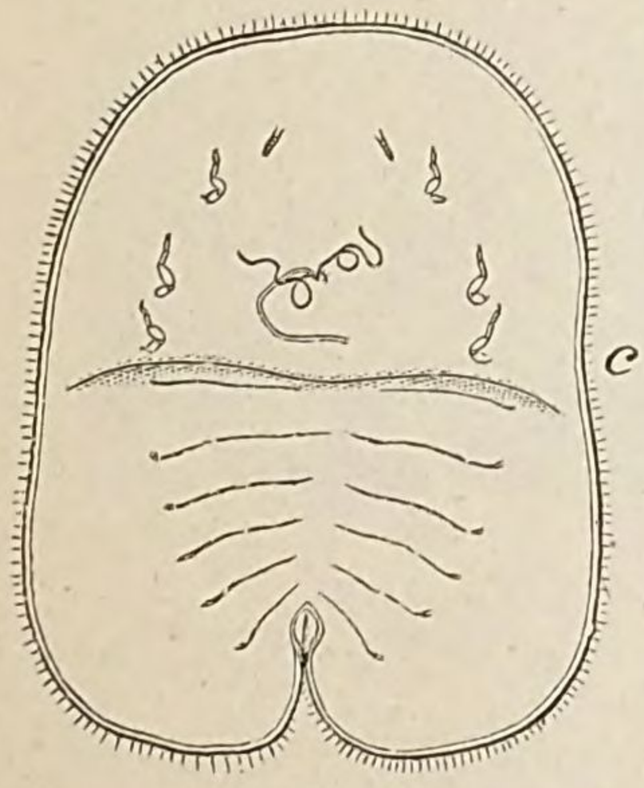




Fig. 3.

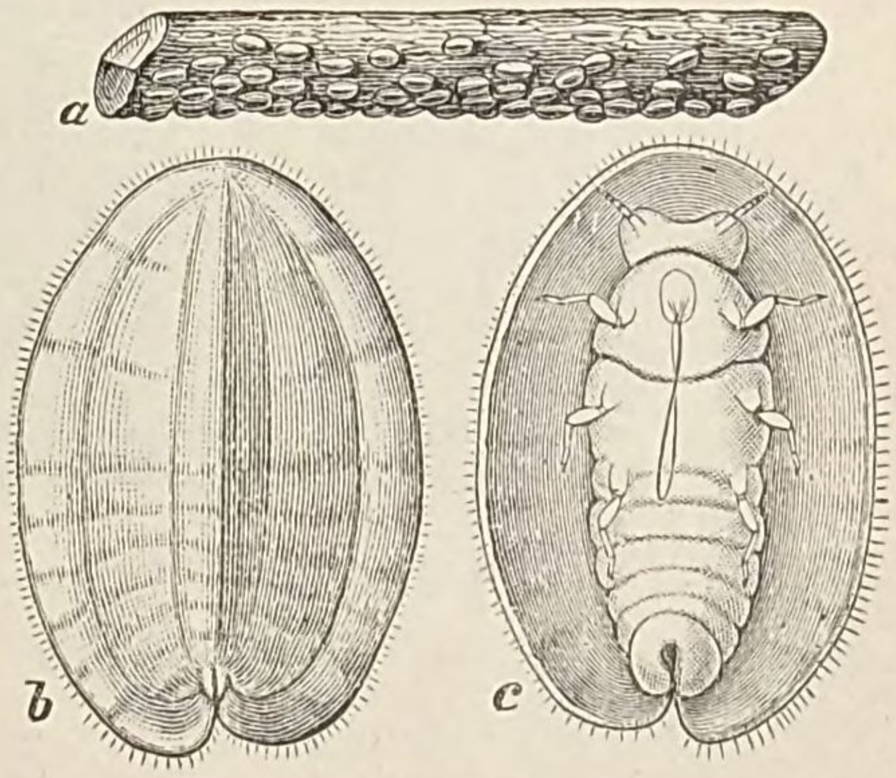
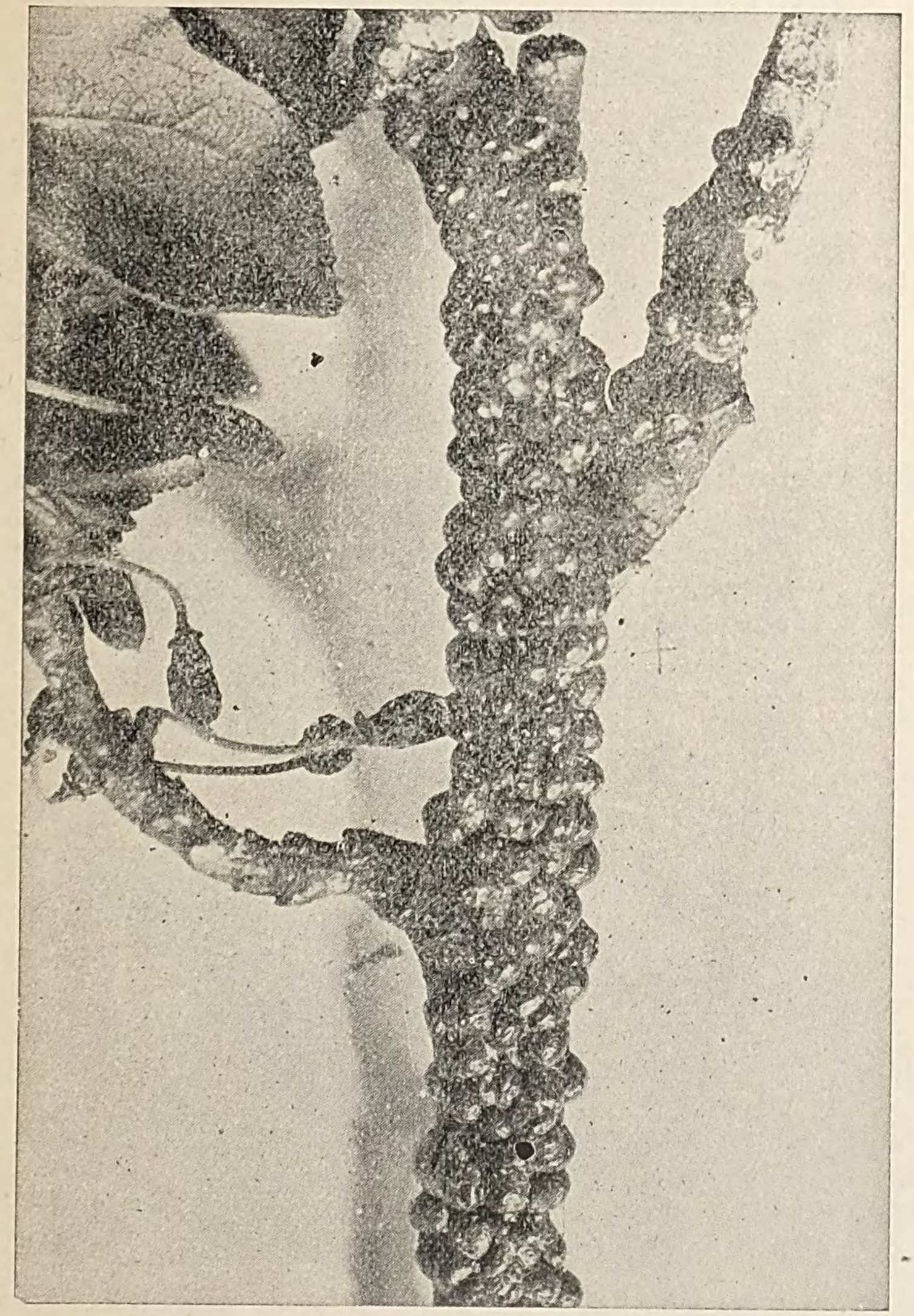



Fig. 4.

## Explanation of Plate IV.

**The plum-tree scale-insect,** *Lecanium ? juglandis* Bouché in natural size, on **plum.** (From Garden and Forest.)

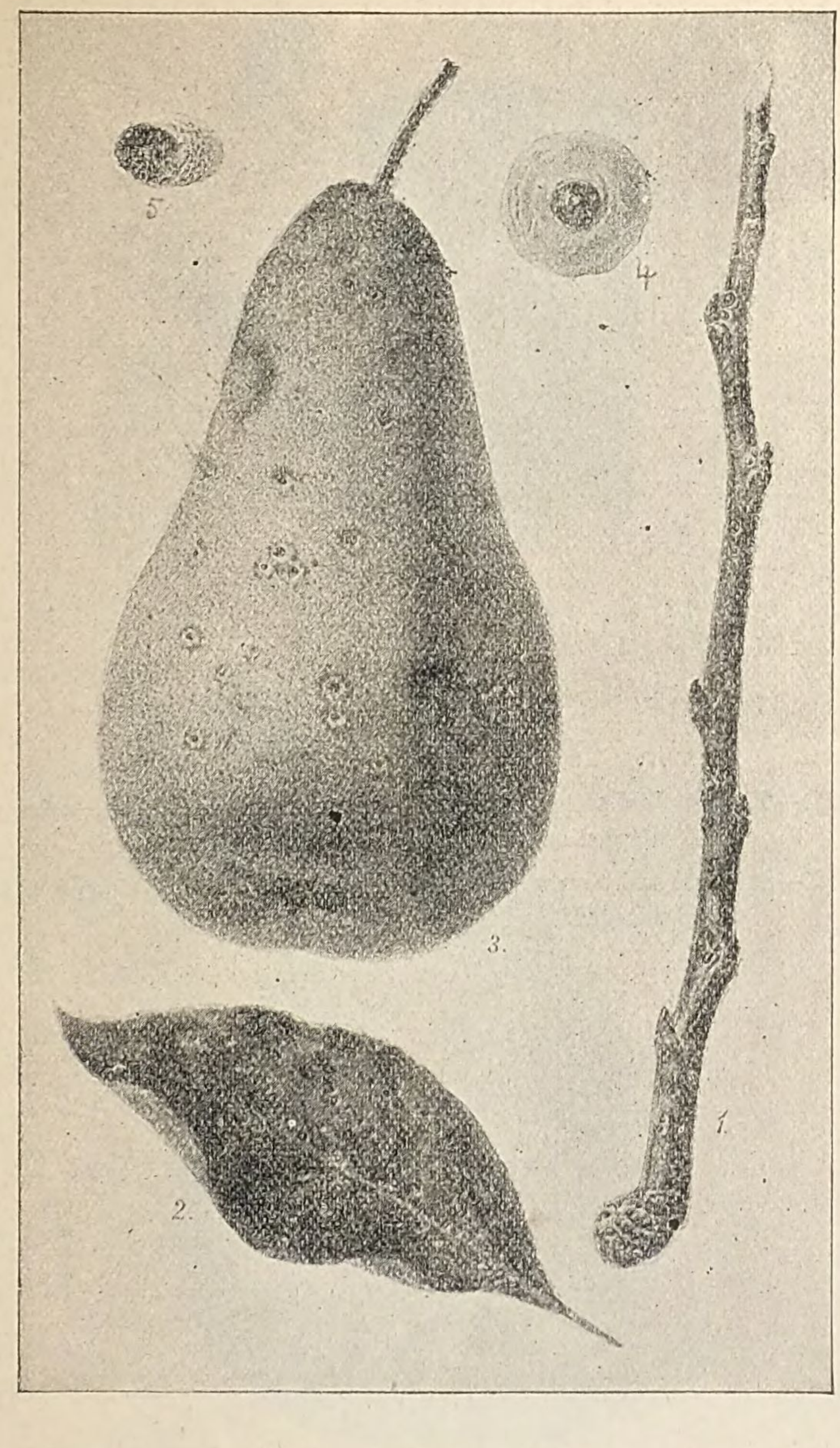
# Plate IV.



## Explanation of Plate V.

Fig. *1*, the San José scale, *Aspidiotus perniciosus* Comstock, infesting a pear twig; *2*, the scales on a leaf; *3*, scattered scales on a pear; *4*, a female scale, enlarged; *5*, a male scale, enlarged. (From the Cornell University Agr. Exper. Station, and by permission of the California State Board of Horticulture.)

# Plate V.



## Explanation of Plate VI.

Fig. 1.—The San José scales, in natural size on an apple branch; scales somewhat enlarged on apple bark at above at the left.

Fig. 2.—San José scales on a pear showing the surrounding ring; *b*, a female scale, enlarged.

# PLATE VI.

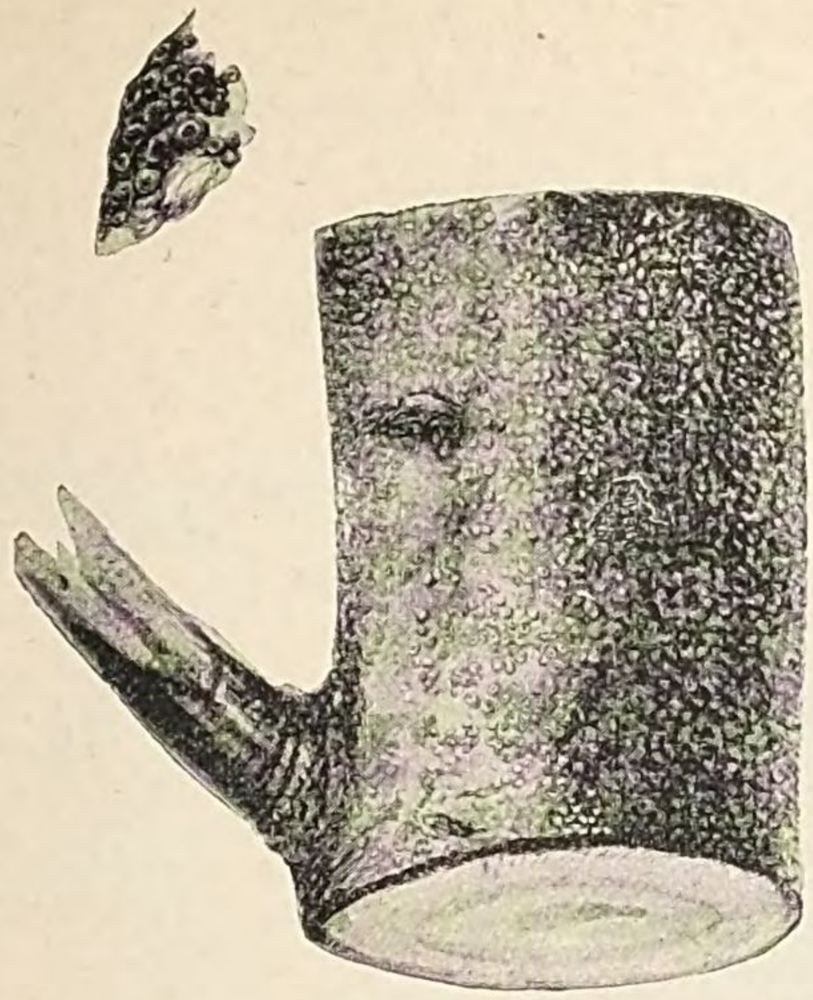


FIG. 1.

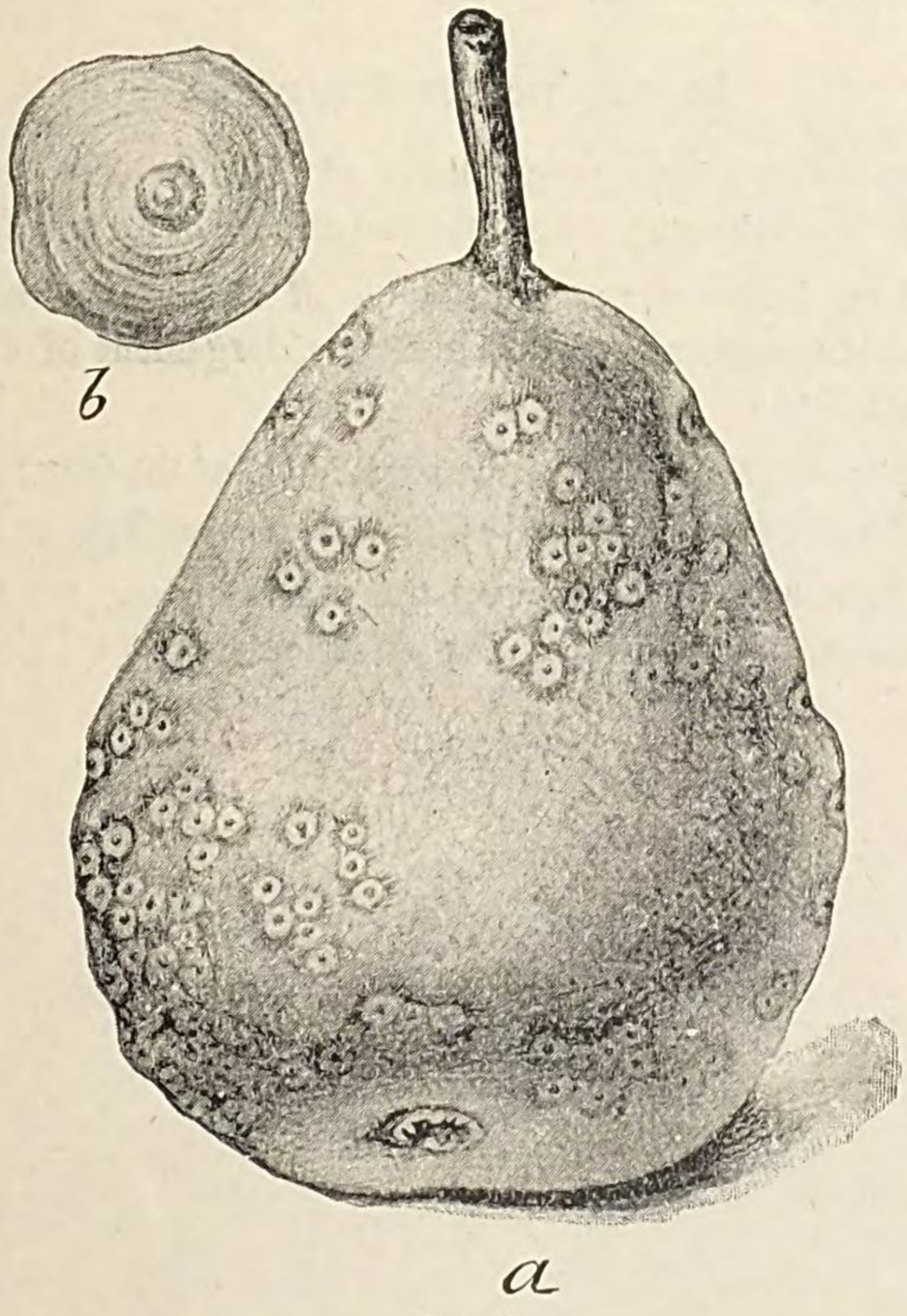



FIG. 2.

## Explanation of Plate VII.

**Fig. 1.**—Enlarged view of the young larva of the San José scale-insect, seen from beneath, with a greater enlargement of an antenna at *b*.

**Fig. 2.**—An enlarged view of an adult female of the San José scale-insect, containing young; at *d*, a still greater enlargement of a portion of its anal fringe.

**Fig. 3.**—A greatly enlarged view of the adult male of the San José scale-insect; its natural size shown in the inclosed crossed-lines at right-hand side.

(The figures of this Plate and the preceding one are from the U. S. Dept. Agriculture—Division of Entomology.)

# Plate VII.

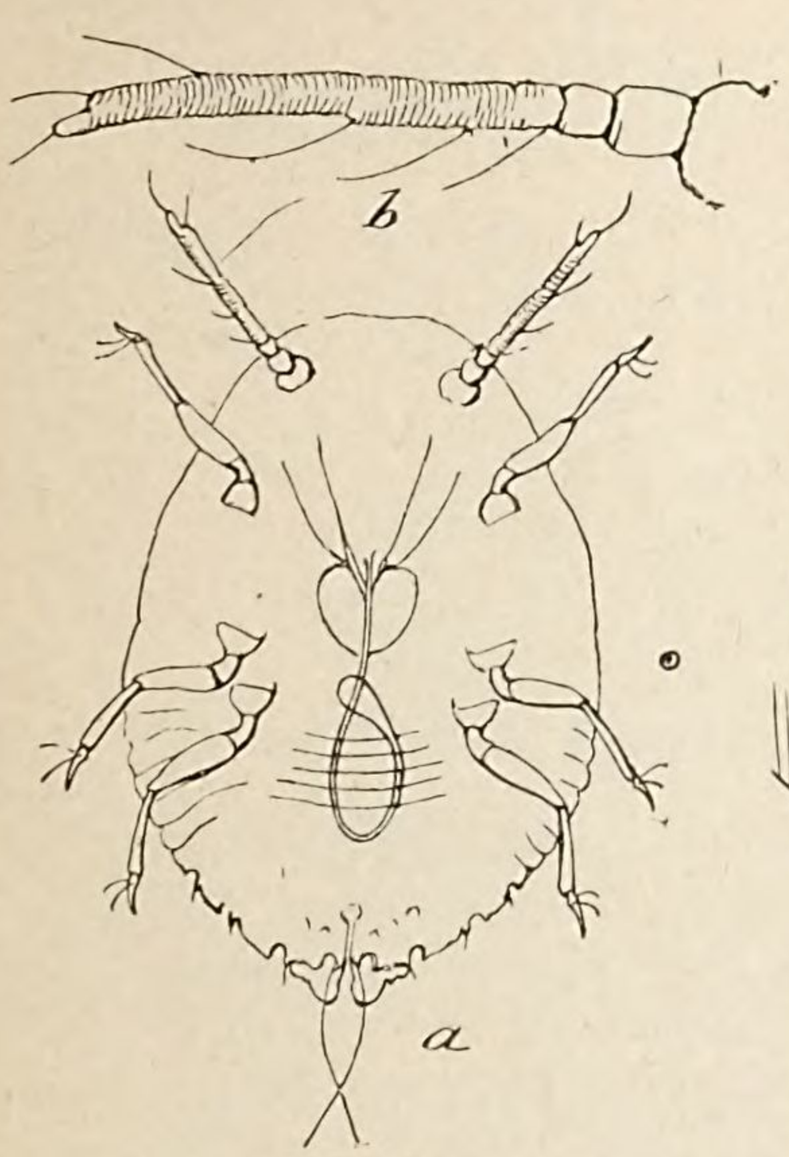



Fig. 1.

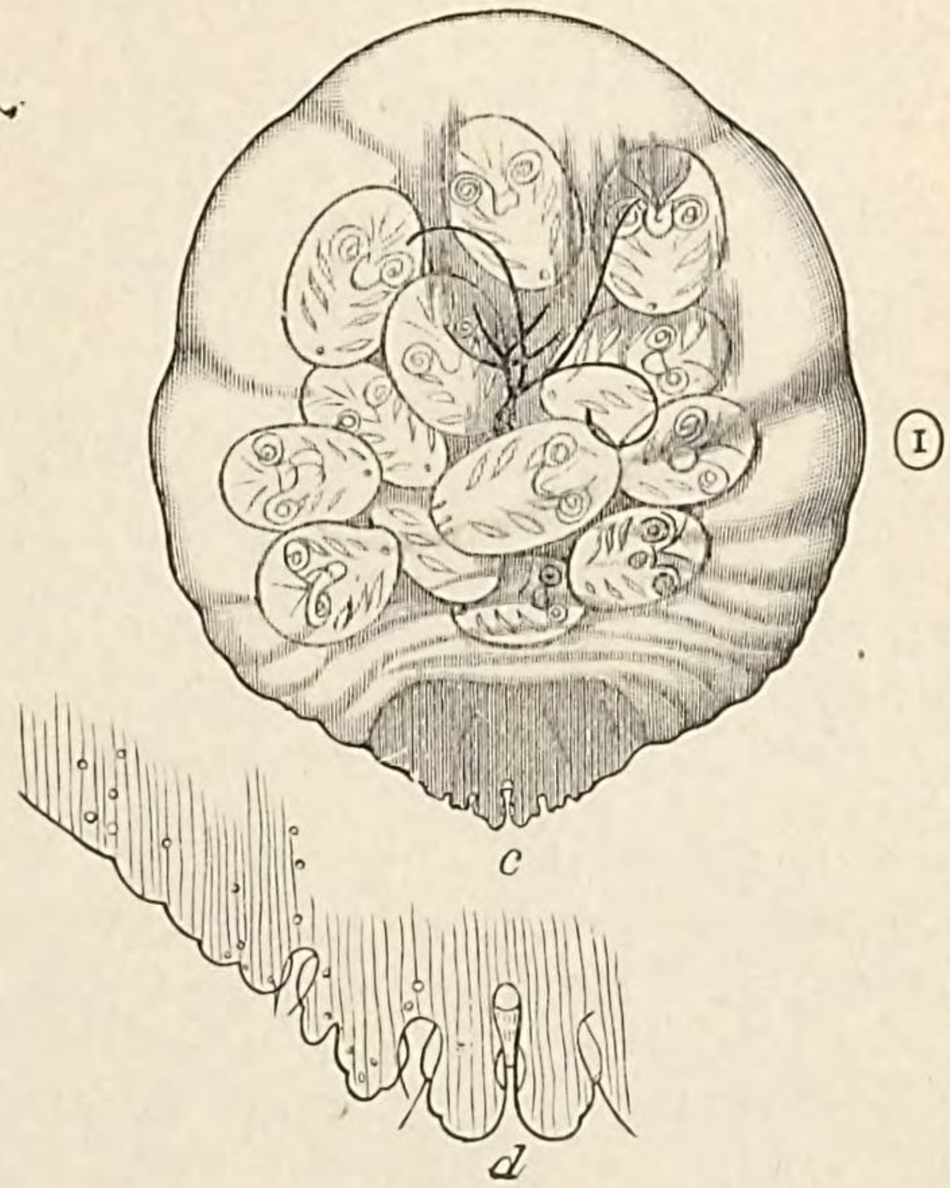



Fig. 2.

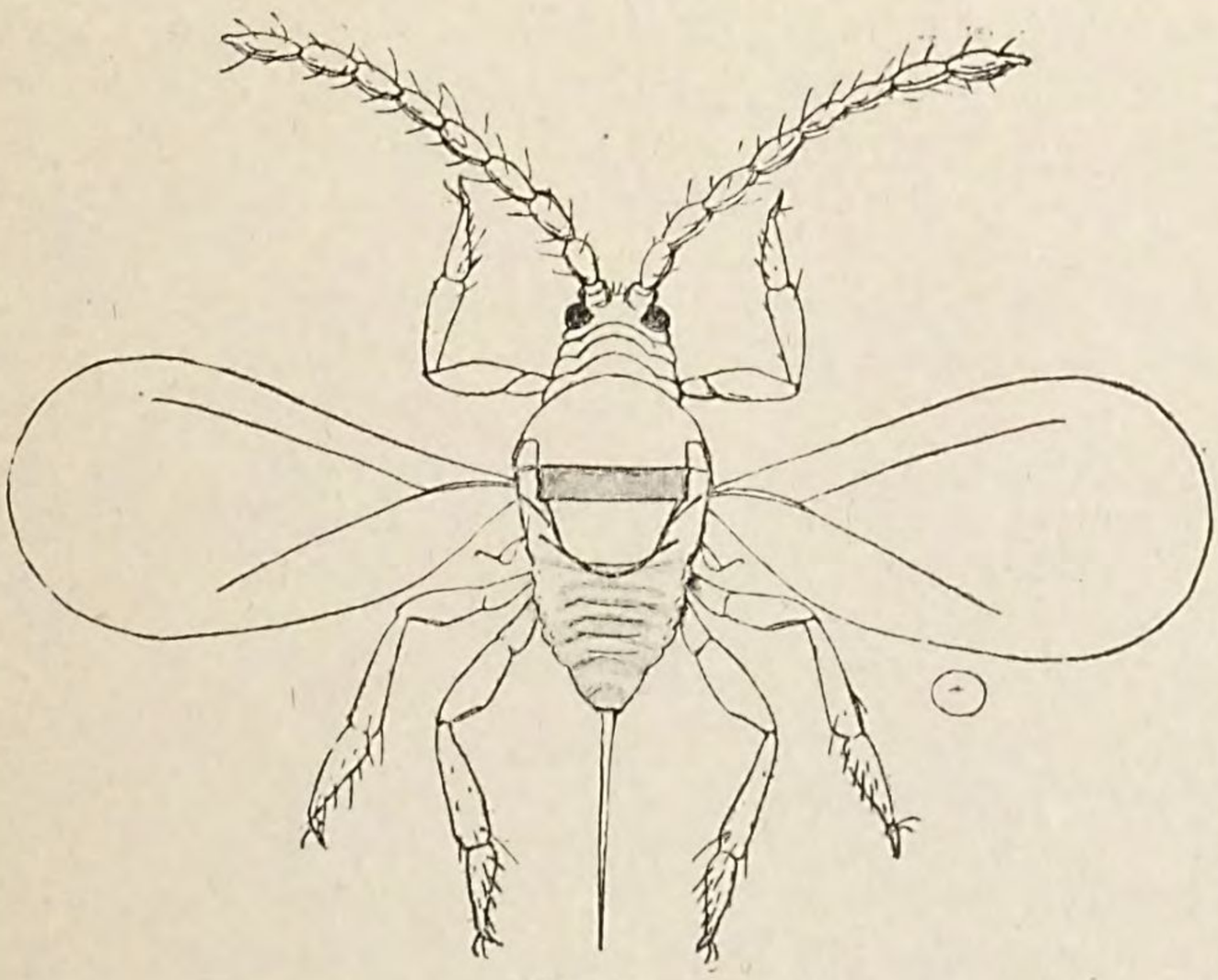


Fig. 3.

**Economic map.** Merrill, F: J. H. Economic map of the state of New York. 59×67 cm. 1894. *Price, unmounted,* 25 *cents, backed on muslin* 75 *cents, mounted on rollers* 75 *cents.*

Scale 14 miles to one inch.

**Museum memoirs.** University of the State of New York. Memoirs of the New York state museum. v. 1, Q. Albany 1889.

Uniform with the paleontology.

1 Beecher, C: E., and Clarke, J: M. Development of some Silurian brachiopoda. 95p. 8 pl. Oct. 1889. *Price* 80 *cents.*

**Natural history.** New York state. Natural history of New York. 28 v. il. pl. maps, Q. Albany 1842–88.

Divisions 1–5 out of print.

Division 1 De Kay, J. E. Zoology. 5 v. pl. 1842–44.

" 2 Torrey, John. Botany. 2 v. 1843.

" 3 Beck, L. C. Mineralogy. 24+536p. il. pl. 1842.

" 4 Mather, W: W.; Emmons, Ebenezer; Vanuxem, Lardner; and Hall, James. Geology. 4 v. pl. maps. 1842–43.

" 5 Emmons, Ebenezer. Agriculture. 5 v. il. maps. 1846 54.

**Division 6 Paleontology.** Hall, James. Palæontology of New York. il. pl. sq. Q. Albany 1847—date. *Bound in cloth.*

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University of the State of New York

# BULLETIN

OF THE

# New York State Museum

VOL. 3 No. 14

SEPTEMBER 1895

## THE GEOLOGY OF MORIAH AND WESTPORT TOWNSHIPS, ESSEX COUNTY, N. Y.

WITH A GEOLOGICAL MAP

PREPARED UNDER THE DIRECTION OF

FREDERICK J. H. MERRILL, PH. D.

BY

JAMES FURMAN KEMP, E. M.

ALBANY

UNIVERSITY OF THE STATE OF NEW YORK

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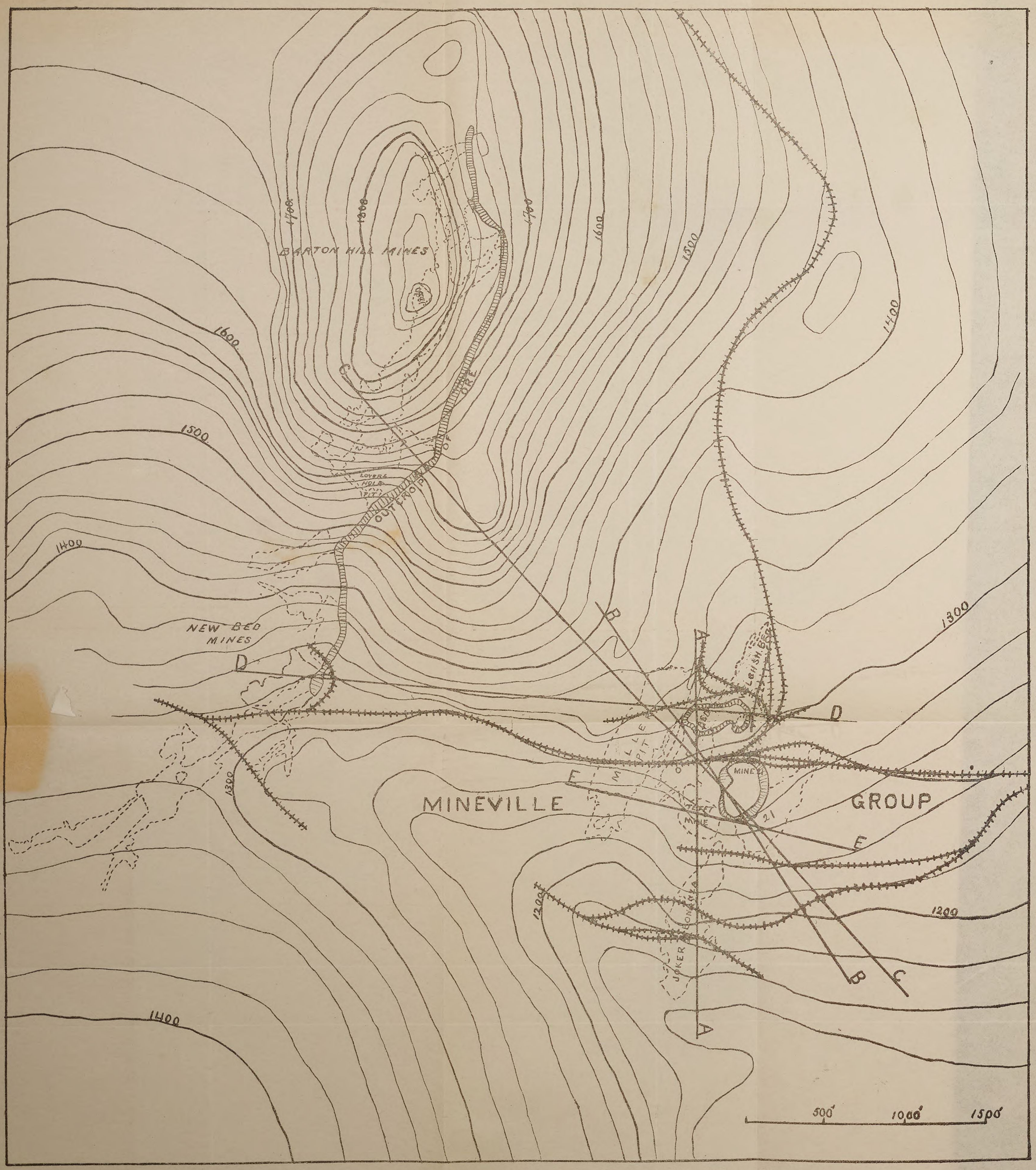
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II. Map of the Mineville District, Essex Co. New York

Based on a Map by S. B. McKee, Engineer of Witherbee, Sherman & Co. and the Port Henry Iron Ore Co.

University of the State of New York

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# INTRODUCTION

The geology of the eastern Adirondacks presents many problems of interest. The townships along Lake Champlain contain within their borders the contacts of the labradorite rocks — (gabbros, norites and anorthosites) with the quartzose gneisses and crystalline limestones; and the later-formed unconformabilities of all these with the Potsdam sandstone of the Upper Cambrian. The crystalline rocks of the Archæan invite study of both igneous and metamorphosed forms, while along the old shore line are the Cambro-Silurian sediments, unchanged, not much disturbed and often rich in fossils. Remarkably little, detailed, field work upon the crystalline rocks has been done in the region since the early survey of Emmons and Hall, 1835–1840. What has been written is incomplete and the stratigraphical conclusions are drawn from too little recorded data. A general review of these papers has been given by the writer, in the Transactions of the New York Academy of Science, v. 12, p. 19, Nov. 1892. Emmons in his Final Report, 1842, devoted almost no attention to the relative stratigraphy of the crystalline rocks and not until 1876, is the question alluded to and then by James Hall only as regards the age of the serpentinous limestones (Amer. Jour. Sci. Oct. 1876) which are spoken of as being later than the Laurentian and earlier than the Potsdam. Dr A. R. Leeds' paper entitled "Notes on the Lithology of the Adirondacks" (Chemical News, Mar. 1877, 36th Annual Report, N. Y. State Cabinet 1877, p. 79) relates to the chemistry and petrography of the anorthosites and trap dikes only.

In 1879 C. E. Hall published a short condensation of what was apparently expected to be a longer contribution. It is entitled Laurentian Magnetite Iron Ore Deposits in Northern New York." (32nd Annual Report of the N. Y. State Cabinet — 1879, p. 133–140.) A brief outline is given of the township geology in the Eastern Adirondacks, and a colored map on a small scale (3 miles to the inch) accompanies the report. Mr Hall divides the Archean into the 1, Lower Laurentian Magnetic Ore Series. 2, Laurentian Sulphur Ore Series. 3, Crystalline Limestones. 4, Labrador Series or Upper Laurentian with Titaniferous Ores. The relations of 2 and 3 are said to be uncertain, but later, in a note, the limestone of 3 is

stated to be later than 4. It is to be regretted that Mr Hall did not complete his paper, for too much attention could not have been given to proofs of these stratigraphical relations, and in the following pages, it will be shown that the conclusions reached in this paper favor his first arrangement. T. S. Hunt in the short description of the geology of Port Henry, (Canadian Naturalist, 2nd series, v. 10, p. 420,) regards the limestones near the town as a great, metamorphosed vein of calcite. C. R. Van Hise, in company with C. D. Walcott and R. Pumpelly, made an excursion in 1890 from Whitehall north along the Delaware and Hudson R. R. to Westport and thence into the mountains near Mt Marcy. They saw much that suggested the deposition of the limestones along an encroaching shoreline of gneiss, and remark also the extensive gabbro area of Westport. In December, 1893, J. F. Kemp read before the Geological Society of America, a paper on the Gabbros on the Western shore of Lake Champlain, (Bulletin V. 213–224) in which the petrography of these rocks is discussed. In December, 1894, the same writer read a subsequent paper on the Crystalline Limestones, Ophicalcites and Associated Schists of the Eastern Adirondacks, (Bulletin VI. 241–262) which treats both of petrography and stratigraphy.

All the other papers that have been written on the region, have small reference to these questions, but as bearing on petrographic points, some are important. Recently an account of the geology of Gouverneur township, on the western side, has appeared from the pen of Prof. C. H. Smyth, jr,* and many facts are adduced. The field work was undertaken in close association with the writer's work on the eastern side and with the general plan of keeping our investigations in harmony. Although no anorthosites are known there, basal gneiss was found practically like that near Lake Champlain and with it is associated igneous granite. Next in succession is crystalline limestone, with some black schists at its base, but serpentinous limestone is practically absent. Above all these is Potsdam sandstone. There is further, a great area of serpentine with red hematite, whose stratigraphic relations remain to be worked out.

*A Geological Reconnoissance in the Vicinity of Gouverneur, N. Y. Trans. N. Y. Acd. Sci. XII. 97, Feb. 23, 1893. A still more important paper by Dr Smyth on the Gabbro contacts in certain townships in St. Lawrence Co. appears in the Bulletin of the Geological Society of America VI. 263.

We hope year by year to add the geology of new townships to those already mapped, until the whole region has been carefully covered. The problems are not easy ones and the many questions require very thorough exploration.

The present contribution is only concerned with Moriah and Westport townships. The field work was done in the summer of 1892, but the writer has been making excursions into the mountains for five years past, and a general introduction is given, based on the data thus gathered.

In the field work efficient assistance was rendered by Mr W. D. Matthew, late Fellow in Geology, Columbia college, and acknowledgments for indispensable aid are here gladly given.

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## GENERAL TOPOGRAPHY AND GEOLOGY

The country along the western shores of Lake Champlain, is diversified in its contours. While the larger share of the water-front is formed of the later sedimentary strata, and while these do not reach in the townships here described, a height of much over 400 feet above the lake (this is not far from 500 feet above tide) they are either soon succeeded in the region south of Plattsburg, by the gneisses, serpentinous limestones, gabbros and anorthosites* as one goes inland, or else are cut by spurs of the latter which jut out in high ridges to the water itself. The heart of the Adirondacks is formed of the anorthosites and the highest peaks are dome-shaped masses of this rock. But the flanks on all sides consist largely of quartzose gneisses, and more or less of serpentinous limestones, which latter have interbedded with them black hornblendic and pyroxenic schists, and are heavily charged with bunches of silicates. The gneisses attain to less altitudes than the anorthosites, although in

*The term anorthosite has been long in use among Canadian geologists, as a special name for the rocks of the Norian series, that consist almost entirely of plagioclase. It is derived from the old French word "anorthose," which is a collective term for the triclinic feldspars. While with New York geologists, norite is generally used for the labradorite rocks, yet increasing observation shows that true norites (i. e. containing plagioclase and orthorhombic pyroxene) are not so general as at first supposed, and as gabbro is a much wider term, embracing under it collectively, the gabbros proper, (plagioclase and monoclinic pyroxene), the norites and the anorthosites, it is here employed.

the region about the outlet of Lake George, these are by no means inconsiderable. The anorthosites occur in general throughout a broad belt, which extends from Port Kent and Saranac Lake, southwesterly 60 or 70 miles. The anorthosites do not form a solid belt, as is the general impression, but are found in ridges of northeasterly trend, with gneiss and crystalline limestone almost always appearing in the valleys. Still around Mt Marcy there is a great group of peaks and no gneiss or limestone has been found in between them.

The relief of the country is not entirely due to erosion, although this has been extensive both by water and ice. One can not resist the conviction when viewing the dome-shaped peaks or knobs, that they are in a large part due to block faulting, and the steep cliffs of Adirondack Pass, of Avalanche Pass and many others, confirm the impression. The remarkable shear-zone at Avalanche Lake* is also an additional proof. In the iron mines it has been a frequent experience to find the ore body cut off by a fault where it has been followed under a gulch. What is true for the small depressions is doubtless applicable on a large scale. The mountains repeatedly have a much steeper eastern face than western, as if presenting to the east, old, eroded, fault-scarps. Erosion both by water and ice has contributed its share in modifying contours, so that now the angles are largely rounded off.

Over the whole country is spread the drift, either sorted or unsorted, and no more striking exhibition of it is to be found in the United States, than in the Adirondacks. As a general thing, aside from the mountains, the country is extremely sandy, and often in the valleys shows unmistakable evidence of having once been lake-bottoms,† on whose shores the deltas still remain.

## GENERAL STRATIGRAPHY

The stratigraphical relations of the Archean crystalline rocks are obscure as decisive evidence is not easy to procure. In the writer's opinion we have the same succession as in Canada, where the Ottawa Gneiss is the lowest member; the Grenville Series of more schistose rocks and limestones lies over it; and through both these are

*J. F. Kemp. The great Shear-zone at Avalanche Lake. Amer. Jour. Sci. Aug. 1892, p. 109.

†H. Ries. A Pleistocene Lake-bed at Elizabethtown, N. Y. Trans. N. Y Acad. Sci. Nov. 1893.

intruded the gabbros and anorthosites of the Norian. Purely lithological names are here chosen to indicate these and they are subsequently described in what is believed to be their stratigraphical succession. It would not be advisable to discuss at length this problem from the restricted area covered by this report. The difficulties in accurate determination and classification rise from the intrusive nature and vast extent of the Norian. Near the contacts of the undoubted gabbros and anorthosites with the gneisses there are all manner of intermediate types of rock, and even far out from the central masses, we find what are regarded as intrusive sheets of gabbroitic gneiss, which possess the characters of both the gneisses and the gabbros. It is hoped that by the close of the summer of 1894, that the whole of Essex co. will have been gone over once and that then these questions can be more intelligently discussed.

**General character of the gneisses.** The gneisses give little decisive evidence of their origin, whether they have been derived from sediments or from granitic rocks. Dr Smyth has shown the latter to be true in the township of Gouverneur on the west side, and the remarkable instances later described, by which the massive gabbros have become gneissic, lends much support to this view for many other regions. So far as they have been examined in the townships specially noted here, they are aggregates of quartz, normal orthoclase, microcline, pyroxene, biotite, hornblende and great quantities of microperthitic orthoclase. The last named is rather the most abundant component. It consists of orthoclase crystals so thickly set with blades of albite that at times they almost seem like crystals of banded plagioclase. Such structures are well known in both igneous granites and metamorphic gneisses. At times, specially near the Bessemer iron ores the gneiss becomes a nearly pure mixture of quartz and feldspar.

**General characters of the crystalline limestones.** The limestones are variable in structure and composition. They are in instances extremely pure carbonate of lime. The quarry opened for the Port Henry furnaces, a quarter of a mile north of Port Henry and east of the Treadway ophicalcite quarry was of this character. But here as elsewhere great bunches of silicates came in and necessitated much waste. It is rare that a bed of any size is met, which is not limited on either side by a black, hornblendic schist or gneiss. The exposed cross-sections show this alteration over and

over. Frequently the limestone becomes more magnesian and is full of the altered pyroxene crystals, which give it the well-known green, serpentinous mottlings. This ophicalcite or ophiolite is widely familiar under the name "Moriah marble," by which trade designation it has been placed on the market as an ornamental stone. G. P. Merrill has shown that the serpentine has resulted from the alteration of a white pyroxene.* The limestones have undoubtedly been penetrated by igneous dikes before their metamorphism, for these show in broken fragments with the limestone in between. Whether all the interbedded, black schist was of this character is doubtful.

The limestone series rests on the gneiss and is later in age.

**General characters of the rocks of the gabbro family.** The gabbros are unquestionably true, igneous rocks of invariable plutonic habit when not rendered more or less gneissic by mountain-making disturbances. Passages of the one into the other can be traced. But even in the purely plutonic or granitoid structures the microscope shows widespread crushings and strainings, the results of dynamic disturbances. The typical anorthosites exhibit nearly pure feldspathic aggregates, specially in the interiors of the Norian mountain ridges. The darker, basic gabbros appear on the skirts of the latter or as more remote outliers. They consist of plagioclase, green monoclinic pyroxene, hypersthene, brown hornblende, titaniferous magnetite, almost invariable garnet and alteration products from all these. Olivine has been discovered but does not appear to be as abundant as in the analogous Canadian exposures described by F. D. Adams.

**General characters of the Cambro-Silurian sediments.** The earliest of the sediments is the Potsdam sandstone. It rests on all the members of the Laurentian in one place and another and sets up into them as embayments. It reaches a maximum altitude of 500 feet above tide at the first Y of the Mineville railway, out from Port Henry. None other of the sediments rises as high at this. Along the lake shore, the Potsdam is succeeded by the Calciferous Limestone, which appears just north of Port Henry and in Westport. In the latter town we find also the still higher Chazy and Trenton. Less attention was given to these than to the crystalline rocks, although later on some further details and lists of fossils are appended.

* Proc. U. S. Nat'l Mus. XII, 595, 1890.

**Brief description of the map.** The accompanying map has been roughly reproduced from advance sheets of the U. S. Geological Survey and from the County Atlas of Essex Co. Only the 100 foot contours are given, to avoid confusion of lines. While not claiming to be more than a general picture of the topography, it does show the elevations with all the accuracy needed for a first draft and as such has been employed. In the subdivision it has been the endeavor to show the areas occupied by the gneiss, the crystalline limestones, the outlying gabbros, the main anorthosite masses, the Potsdam sandstone and the Lower Silurian limestones. Where all rocks are concealed by drift, this has its appropriate sign. Practically all the roads were traversed in Moriah and Westport and a corner of Elizabethtown. The only omitted area is a small one in the extreme northwest of Moriah.* But it is recognized that some outlying gabbro areas may have been overlooked, although all accessible hills were climbed. On many the forest growth and smaller vegetation conceal all exposures. Some gneissoid forms of anorthosites may be included in the areas drawn as gneiss, for as already remarked the intermediate varieties are extremely hard to classify, even when the prominent types are readily recognized. The geological sections will serve to indicate the stratigraphical relations in several places.

## OUTLINE OF THE GEOLOGY OF MORIAH

An examination of the accompanying map will show that the gneisses with iron ores make up the greater part of Moriah. There is also a belt of crystalline limestone and black schist in Port Henry and another east of Ensign Pond. Along the Lake Champlain front the Potsdam sandstone is well developed, and the Calciferous shows in one small spot just north of Port Henry. The later sediments although present in the townships on the north and south are absent in Moriah. The anorthosites appear in the southwest and form one especially high hill, Harris Hill, and several others, hardly inferior.

Outlying masses of gabbros are frequent and often strongly gneissoid. A great sheet of gabbro has been cut by drill cores near Mt Bob, Mineville, and an enormous mass of it underlies the Cheever Mine, outcropping all along the lake. Another great sheet, at least 250 ft thick forms the middle (horizontal) third of Bald Peak. Several diabase dikes have also been met. Geological sections accompany the map.

*Since filled from observations made in 1894.

## OUTLINE OF THE GEOLOGY OF WESTPORT

The southern part of Westport is mainly gneiss, but the northern is is all anorthosite and gabbro. The anorthosites have an extended development in Split Rock Mountain, and also appear in the southeast. The gabbro is especially important in the central portion. The sedimentary rocks mark the southeastern lake shore. The Potsdam, Calciferous, Chazy and Trenton are all well shown.

## PETROGRAPHY

**Petrography of the gneisses.** There are several varieties of gneiss as shown by the thin sections. These occur, forming the larger portion of what is regarded as the basal series. Gneisses are also found as immediate associates with the undoubted anorthosites, and such are doubtful forms for stratigraphic classification. The endeavor has been made to differentiate the certain and well marked varieties in each series from the intermediate or doubtful ones.

The most characteristic gneiss in the undoubted exposures of the basal series, is formed by an aggregate of quartz and microperthitic orthoclase in largest amount, with which are orthoclase, plagioclase and brown biotite in less degree. The rock shows no features at all remarkable among gneisses. The accompanying figure (Fig. 1)

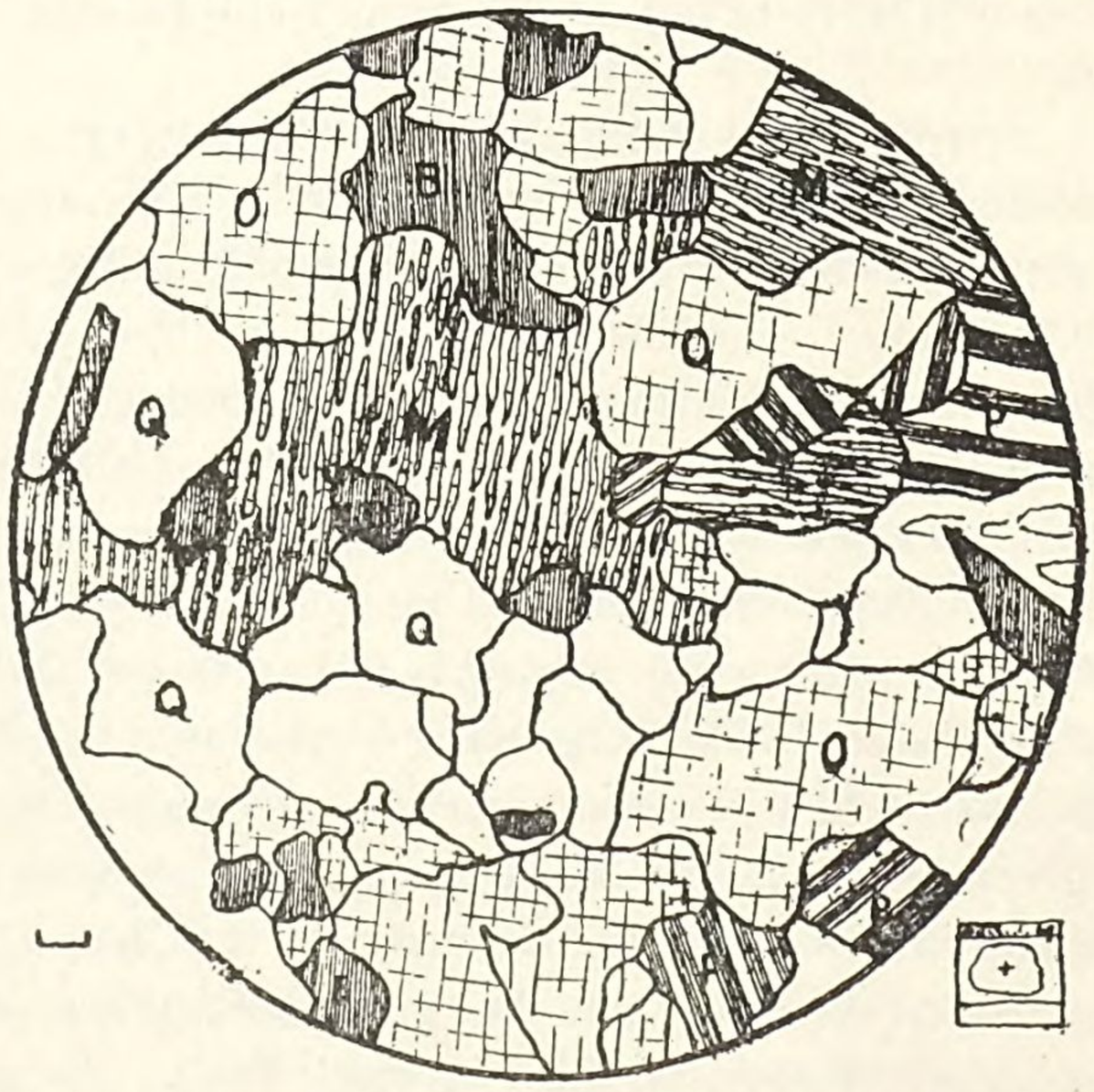



FIG. 1.—Common biotite-gneiss, Bulwagga Mountain, Moriah. O is orthoclase; M, microperthite; Q, quartz; B, biotite; P, plagioclase.

gives a fair illustration. Occasionally a little garnet is seen, but it is a very light colored or quite colorless one, in contrast with the deeper pink variety of the anorthosite derivatives. It shows also no tendency to characterize the contacts between the dark silicate and the feldspar, as is the case with the anorthosites. It contains quartz inclusions and is thus doubtless a result of metamorphism and of late formation in the history of the rock. A few minute zircons are also seen, and a few grains of magnetite. The gneisses do not show wide spread evidence of dynamic disturbances. While one or two exposures, exhibit the operations of crushing forces, the others from the main ridges are quite without such effects. These latter are far more widely shown by the anorthosites in which they seldom fail. Prof. Smyth after examination of the writer's slides of gneisses states that dynamic effects are much more widely shown by the gneisses on the western side of the mountain.

Along the lake front just above the Cheever dock, and near the great gabbro mass, are several exposures of brecciated gneiss. This seems to have been a micaceous variety originally, but the dark silicate is now altered beyond recognition. Even in the outcrop the rock is visibly crushed into small angular fragments, now recemented, and in the slides this comes out in a still more marked way. Strained fragments of quartz, microperthite and chlorite fill the field. The crush was apparently caused by the intrusion of the neighboring gabbro. A less common variety of gneiss contains, instead of biotite, dirty green hornblende, but all the other features are essentially like the micaceous ones.

In the walls of the non-bessemer ore bodies the gneisses appear to become somewhat richer in dark silicates as the ore is approached. Near the ore the slides show chiefly plagioclase, with abundant green hornblende, green augite, scattered magnetite and titanite.

The lean ore is chiefly mixed with pyroxene, black in the hand specimens, but of a beautiful, emerald green in the sections.

Much black hornblende is also met. Diamond drill cores near Mt Bob, Mineville, have shown as the wall rock of the Bessemer ores a very feldspathic gneiss, with scarcely a trace of a dark silicate. The lean ore is mixed with quartz and feldspar. There is some reason for thinking that this contrast of wall rock may often show itself. Gneisses are also met, practically like those cited as most

typical and characteristic; except that they contain green monoclinic pyroxene instead of either hornblende or biotite, or else this in association with hornblende. Their acid character, possessing as they often do, much quartz, causes them to depart from the gabbro types. Especially towards the great masses of gabbro and anorthosite, gneissoid rocks appear that are difficult to classify in their stratigraphical relations. They contain abundant plagioclase, augite, hornblende and deep pink garnets and are probably gneissoid forms of gabbro. Still the relations are much confused. Towards the contacts, pegmatite masses are also met at times of great size, but they are better shown in adjoining towns.

**Petrography of the limestones and associated black schists.** In thin sections the pure white limestones show little of interest. They contain flakes of graphite, small scales of phlogopite, an occasional apatite crystal and little else. Such occur at the furnace quarry on the ridge just north of Port Henry; below this along the lake shore; and south of the Pilfershire Mine.

The limestone afforded is a very pure calcium carbonate at the first mentioned locality. It has yielded some unique crystals of calcite. Often closely associated with this latter is the mottled serpentinous limestone or ophicalcite. Its best exposures are in the belt along the ridge from a point north of the Cheever Mine and thence southward to the Lee Mine. Quarries have been opened at several points. It outcrops again west of Moriah Center, on the present road to North Hudson, and also on the old and now abandoned highway, nearly due north of Ensign Pond. The rock is a dolomitic marble with copious green mottlings of serpentine. At times these are evenly distributed and a quarter inch across as a maximum, and then the stone is very beautiful, when polished, but such pieces can seldom be obtained of large size or of even texture. The masses of serpentine too often form great blotches, up to several inches across, and mar the appearance of the stone. Small bunches of silicates also appear and afford white pyroxene, brown tourmaline, rose quartz, beautiful crystals of brown hornblende, titanite, etc., as later set forth. Similar serpentinous marbles have in Warren county afforded specimens thought to be Eozoon, as described by A. M. Edwards (Proc. Lyceum Nat. Hist. N. Y., 1870, p. 96). G. P. Merrill has also written of them and is able to show

in many cases that the serpentine is secondary after pyroxene, but some forms of serpentine seemed to him not to be referable to this original. In my slides, the core of pyroxene is usually present and the process of alteration is graphically shown. The total effect resembles an altered olivine crystal most closely. In one instance the core proved isotropic and showed no trace of an optic axis. It would appear to be an isometric mineral of quite high index.

The limestone series is accompanied by masses of silicates of all sizes from small bunches up to large lenses. There are also beds of dark schistose rocks that are an inseparable associate, and no extended section was met devoid of them. The small bunches are especially numerous near the contacts with gabbros, and in the Delaware and Hudson railway cuts, two miles and less above Port Henry, along the lake they are very numerous. They assume very fantastic shapes, from the small foldings and stretching of the limestone, and specially resemble snakes. These are here regarded as due in part to the metamorphism of siliceous portions of the original limestone, but still more often to bunches of minerals formed by contact action along the intruded gabbro. They have been afterwards stretched in the general dynamic disturbances which have given rise to such extended foliation. The limestone everywhere gives evidence of being very plastic under these conditions and has wound itself around the inclusions and followed them in many intricate curves.

The inclusions exhibit in thin section, plagioclase and hornblende in greatest amount, and with these phlogopite, scapolite, pyroxene, quartz and probably orthoclase. In larger ones fine crystals of brown tourmaline and light brown hornblende, titanite and rather rudely bounded pyrrhotite appear. All these show characteristic forms. Very similar mixtures are met at Van Artsdalen's quarry near Philadelphia, Penn. as has been cited by the writer (Trans. N. Y. Acad. Sci. Vol. XII. p. 74, Jan. 23, 1893) where they are referred to the contact action of gabbro. They are practically duplicated in the bunches of silicates contained in the marbles on the contact with the hornblende granite of Mount Adam and Eve, Orange co. N. Y. A very complicated and interesting mass of silicates occurs in the cut on the railway from Port Henry to Mineville, just at the grade crossing of the northeastern highway in O8, of the map. Garnet,

quartz, tourmaline, phlogopite, and magnetite can be readily recognized, while in the slides, scapolite is abundant and small masses of titanite are everywhere through the somewhat altered phlogopite. Pyrite and apatite also appear. It is an unusually complex bunch of silicates in the limestone series. The dark schistose rocks that penetrate the limestones in instances apparently parallel to the foliation are shown by the thin sections to consist of brown hornblende, rather scarce brown biotite, plagioclase, some pyroxene and magnetite. Either hornblende or augite may fail. The rocks are at times quite gneissic or even massive, as in the great sheet just over the limestone of the abandoned Pease Quarry in the outskirts of Port Henry. In thin sections these more massive sheets bear the strongest resemblance to the metamorposed dikes from the Hudson River shore above West Point, described by the writer in the American Naturalist for August 1888. There is much that leads one to regard them as intruded dikes and sheets, doubtless contemporary with the gabbro, and offshoots from its magma, that have afterwards become foliated by metamorphism. Such a dike from the limestone quarry near the Pilfershire Mine is shown in the accompanying reproduction of a photograph. It is clearly a broken dike, between whose separated fragments the limestone has been forced. The mineralogy and structure of this is precisely like the gneissic ones above referred to, but less certainty is felt that the more schistose ones may not be metamorphosed sediments. Very similar beds occur in the limestones of Gouverneur, St Lawrence co. where they are regarded by C. H. Smyth, jr as altered sediments, (Trans. N. Y. Acad. Sci. XII p. 102 Feb. 23, 1893) and where they are far west of any exposure of gabbro. Their noticeable parallel arrangement in the limestone makes it seem extraordinary that dikes should have been so regular unless the apparent bedding of schists and limestones is due to mountain making processes. One or two beds of light grey gneiss with graphite and sillimanite were met with in the limestone series. One occurs along the highway south of the Pilfershire mine, N8 on the general map. It may represent a silicious bed, deposited in with the limestones.

**Petrography of the gabbros and anorthosites.** In the high knobs of Mount Harris, in the western portion of Moriah, near Ensign Pond, and also in the northern part of Westport, the

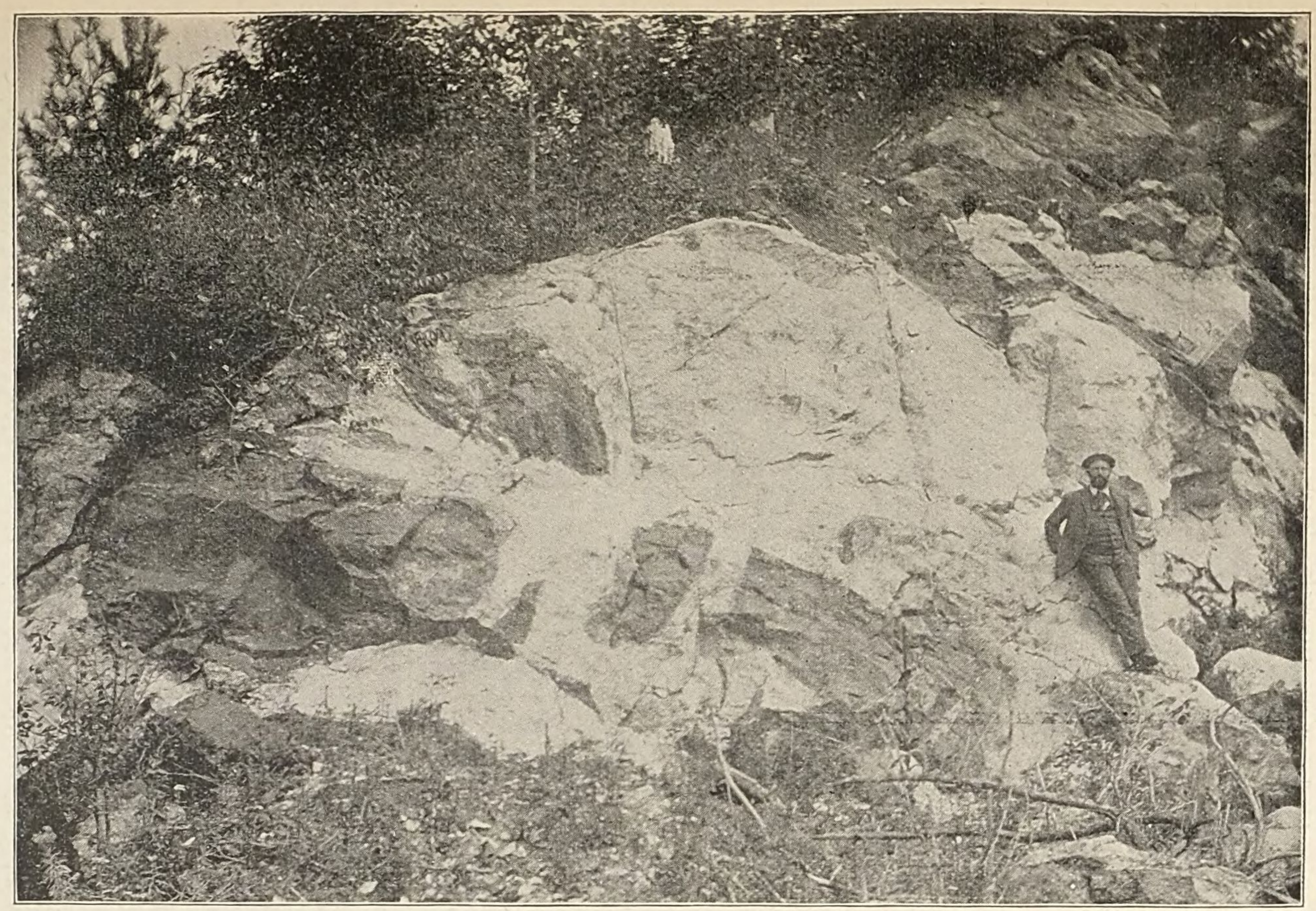


PLATE I — View in a quarry of white crystalline limestone, near the Pilfershire Mine, Moriah Township. The limestone has been penetrated by a dark dike of gabbro which has been subsequently broken by dynamic disturbance. The limestone has been forced in between the sundered ends of the dike. The view is intended to illustrate the plasticity of limestone under pressure.

anorthosites make up the country. The most massive variety consists of large, bluish labradorite crystals, up to an inch and a half in length, with almost no traces of dark silicates. The rock is nearly pure feldspar, but it has been subjected to powerful dynamic disturbances and now exhibits a mass of larger nucleal fragments, often of considerable size, surrounded by fine breccias of the same. The specific gravity of the large pieces, free from garnets, lies between 2.65 and 2.71, proving them to be labradorite. The thin sections bring out the crushed condition still more strongly. Even small brecciated cracks penetrate the larger pieces. The comminuted feldspar is more or less altered, and often presents a fibrous or scaly mass of sericite. Other darker varieties from this western border of Moriah, contain bisilicates and tend to assume gneissoid forms, from the alignment of these, in continuous bands. The plagioclase is much smaller than in the first mentioned variety. The dark silicates are green monoclinic pyroxene, deep brown, almost opaque hornblende, and less common hypersthene, in about this order of abundance. There is also more or less titaniferous magnetite. The two pyroxenes are evidently original minerals and much of the brown hornblende is also, but there are cases, later described where it forms one of the zones in the reactionary rims, which give the impression, that some of it may be secondary. Deep pink garnets are universal and often associated in a most intimate way with the pyroxene. The same cracks pierce both minerals, and though the line of demarcation is sharp, it makes the observer suspect that the garnet has resulted from the pyroxene. The reactionary rims of garnet give some added ground for this suspicion. But garnet often appears alone with no bisilicate near it, and in such cases it is probably an original mineral, as garnet often occurs in this relation in plutonic rocks. A microscopic drawing of a typical anorthosite is given by the author in a paper in the Amer. Jour. Sci. for Aug. 1892, p. 111, Fig. 2.

Generally outlying from the main exposures of anorthosites and separated from them by intervening gneiss are the areas of rocks, marked gabbro on the map. The gabbros exhibit massive, coarsely banded and very thinly laminated forms, and in several places the unbroken transition can be followed from one into the other.

In general, the massive gabbro makes the impression of a dark

rock upon the observer and this is due to the abundance of magnetite grains and dark silicates. The minerals present are plagioclase, green monoclinic augite, brown hornblende, hypersthene, garnet, titaniferous magnetite and titanite. The more important ones of these are shown in the accompanying figure (Fig. 2) which is a little

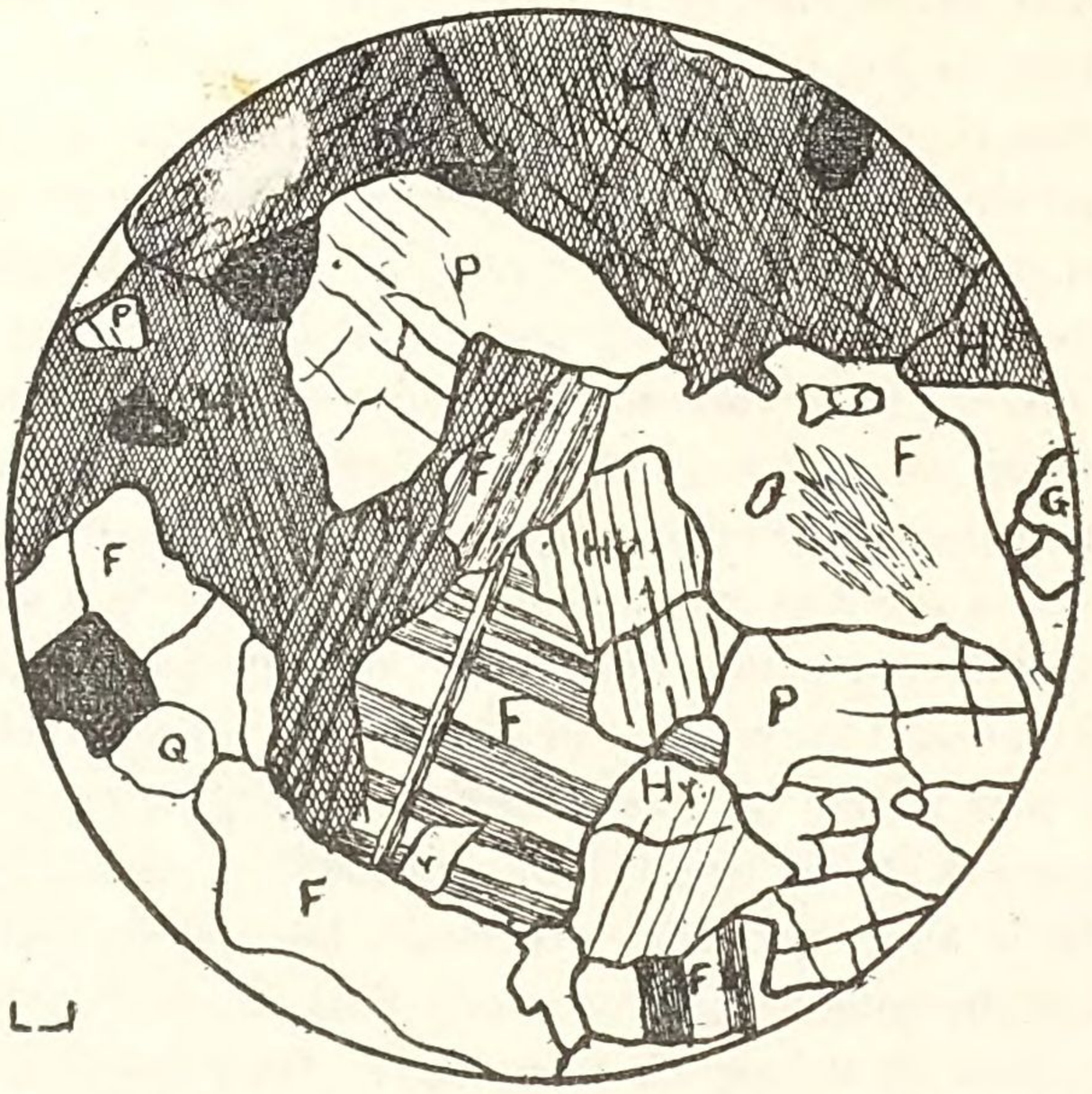



FIG. 2.—Gabbro without reaction rims—near Ensign Pond, Moriah. F is labradorite; P, augite; Hy, hypersthene; H, hornblende; Q, quartz; G, garnet; M, magnetite.

richer in hornblende than the average. The rock is blotched with light green from the altered feldspar, and has faint, pink streaks running through it, due to the garnets. These latter give it a peculiar reddish cast that is very characteristic. The feldspars are now largely altered to saussuritic matter, but when not too far gone they have a broad, lath-shaped outline, more or less idiomorphic, and are rather coarsely twinned. At times they are filled with minute dots or crystals of brightly polarizing character which are so small as not to be easily recognized, but they are probably pyroxene. Less commonly, polygonal scales of a brown color and in geometrical arrangement are to be seen. These latter are generally regarded when seen in other exposures as a micaceous variety of ilmenite. The successive zones of grains of garnet and brown hornblende between the dark silicates and the feldspar, or surrounding the

magnetite are extremely interesting. They have been described and figured by the writer in the Bulletin of the Geol. Soc. of Amer.— V. 218, and are regarded as due to the reaction of the bisilicate or other basic mineral and the feldspar on each other. Olivine is found in the gabbros on the lake shore north of Port Henry, and in the walls of the Split Rock Mine — on Split Rock Mountain, Westport.

In the gneissoid varieties of gabbro, hornblende appears in notable preponderance, and in the extreme cases, of very thin lamination it is the only dark silicate present. It is quite certainly of secondary origin.

**Petrography of the palaeozoic sediments.** The microscope yields little in addition to the macroscopic examination. The Potsdam sandstone shows considerable calcite, in small rhombs mingled with the quartz grains. The Calciferous cherty limestone consists of fine grained calcite crystals and the chert is devoid of fossil organisms of any sort. The others were not ground in sections.

**Dikes.** These two townships are not as prolific in dikes as others to the north. Several have been noted recently by Kemp and Marsters* and determined with the microscope. They are all diabase or closely related types. There is a bunch of dikes on Mill brook, just west of the lake in Port Henry. One or two cut the ore beds at Mineville. A fine one is in a hill a short distance northeast of Moriah Corners, (No. 56 in O5 of map) where it has been mined out for an ore body. Several others are exposed along the lake shore a mile or two north of Westport, — and others appear in the old iron mines on the west side of the Split Rock ridge. Porphyries, tho' known in the next township north, have not been met.

## GENERAL CONCLUSIONS

The two older series of rocks, the gneisses and the crystalline limestones were formed before the intrusion of the anorthosites and gabbros. These latter came up as great plutonic masses and as offsetting sheets penetrating the older rocks, and contributing to their metamorphism. Much faulting and folding ensued, by which the latest intrusions became involved in the earlier rocks in very

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*The trap dikes of the Lake Champlain Valley. Bulletin 107, U. S. Geol. Survey.

puzzling ways, and by which they received brecciated and gneissoid structures. This metamorphosing process then ceased in pre-Cambrian time and on the flanks of the old crystallines were laid down the Potsdam sandstone and the Silurian shales and limestones, all of which show comparatively unaltered forms and not greatly disturbed positions. Their dips are low, mostly to the north, and beyond comparatively slight faulting they have not been participants in heavy movements. What disturbance appears is probably to be attributed to the upheaval of the Green Mountains.

There is evidence in neighboring townships which indicates that the Cambro-Silurian sediments formerly reached well up into the valleys, at least in the case of the Potsdam, but that they have been since extensively eroded.

## IRON ORES

The ores are all magnetite, but as already outlined are of two varieties. The one that is useful and merchantable to-day is practically free from titanium. Variable amounts of phosphorus and sulphur, occasionally reaching high percentages are present. These ores seem to be uniformly associated with the older gneisses. The second variety contains titanium, often in very considerable amount. The limestones are devoid of ore in these townships. In Moriah there are the following mines, all of which have been practically worked except the last named. They are all non-titaniferous. The Mineville Group; the Barton Hill Group; the Cheever Group; the Pilfershire and Pease Pits; the Lee Mine; and the Coot Hill Mine. In Westport there are the following which are all titaniferous, except perhaps the first named. The Nichols Pond Mines; the Split Rock Mines; and the Ledge Hill Mines. None of these latter have been worked in years.

The general merchantable ore in Moriah is non-bessemer, for only the mines on Barton Hill furnish bessemer ores. The following table illustrates their composition. The Lee mine is quite sulphurous. The Pilfershire and Pease pits have been long abandoned. The Coot Hill mines have no serious showing of ore and were an ill-advised enterprise; and the mine put down on the county atlas as occurring north of Crowfoot pond is purely imaginary. The outcrop of gabbro or gabbro-gneiss near Mr J. Lewis's house, Moriah,



PLATE II

PANORAMA OF MINEVILLE, N. Y.
Looking southeast. Lake Champlain in the distance.

and near some prospects that he has opened make it seem probable that the ore will prove titaniferous, but no analyses are available. The Barton Hill mines and their prolongation, the Fisher Hill and Burt Lot openings are bessemer, and some lots have been found surprisingly low in phosphorus. They occur at a higher horizon in the gneisses than the Mineville group as will be later shown by sections.

## TABLE OF ANALYSES

| | Bessemer Ores — | | Non-Bessemer Ores — | | | | |
|---|---|---|---|---|---|---|---|
| Mine | Barton Hill. | Fisher Hill .. | Welch Shaft | Miller. | Old Bed. | "21" | Cook Shaft |
| Authority .. | Birkinbine . | Tenth Census. | do | do | do | do | do |
| Fe | 65 12 | 46.96 | 57.71 | 60.54 | 62 64 | 62 10 | 62.80 |
| P | 0.0289 | 0.03 | 1.266 | 0.830 | 0.908 | 1.198 | 0 870 |
| $TiO_2$ | ..... | present. | present. | present | present | present | present. |

| | | | Titaniferous Ore. | | | |
|---|---|---|---|---|---|---|
| Mine .. | Cheever. | Lee | Split Rock | do | do | Cook Shaft — Humbug Vein — F. S. Witherbee. |
| Authority | Tenth Census. | do. | ..... | . . . | . . | |
| Fe | 63.86 | 45 01 | 44 77 | 32 59 | 40 42 | |
| P | 0 680 | 0 047 | .... ... | | | |
| $TiO_2$ | present. | Absent | 13.15 | 14.70 | 16 37 | Circa 20. |

In the octahedral ore of the Lovers Hole Mine, T. R. Woodbridge found with iron 68.58 and phosphorus .004, titanic oxide .147. Thus where found in these ores it is in very minute amount.

The beds are often disturbed by small faults and very frequently these are occasioned by the intrusion of a trap dike. In fact hardly a mine has failed to reveal these. Profounder faults may also intervene and cut off the ore entirely as at the Cheever mine.

The ores in the richest forms are granular. They have for a gangue, pyroxene as a general thing, and in the thin sections of lean ores this is seen to be of a brilliant emerald green hue, though black in the thicker masses. Grains of apatite are at times very abundant, and are present in most of the mines. Pyrite is notable in a few. Bessemer ores are afforded by several very large openings.

### GENERAL FEATURES OF THE TITANIFEROUS ORES.

The titaniferous ores are in true igneous gabbro, which has been more or less metamorphosed and to which a foliation or banding has been imparted by pressure. The ore-bodies are thus flattened

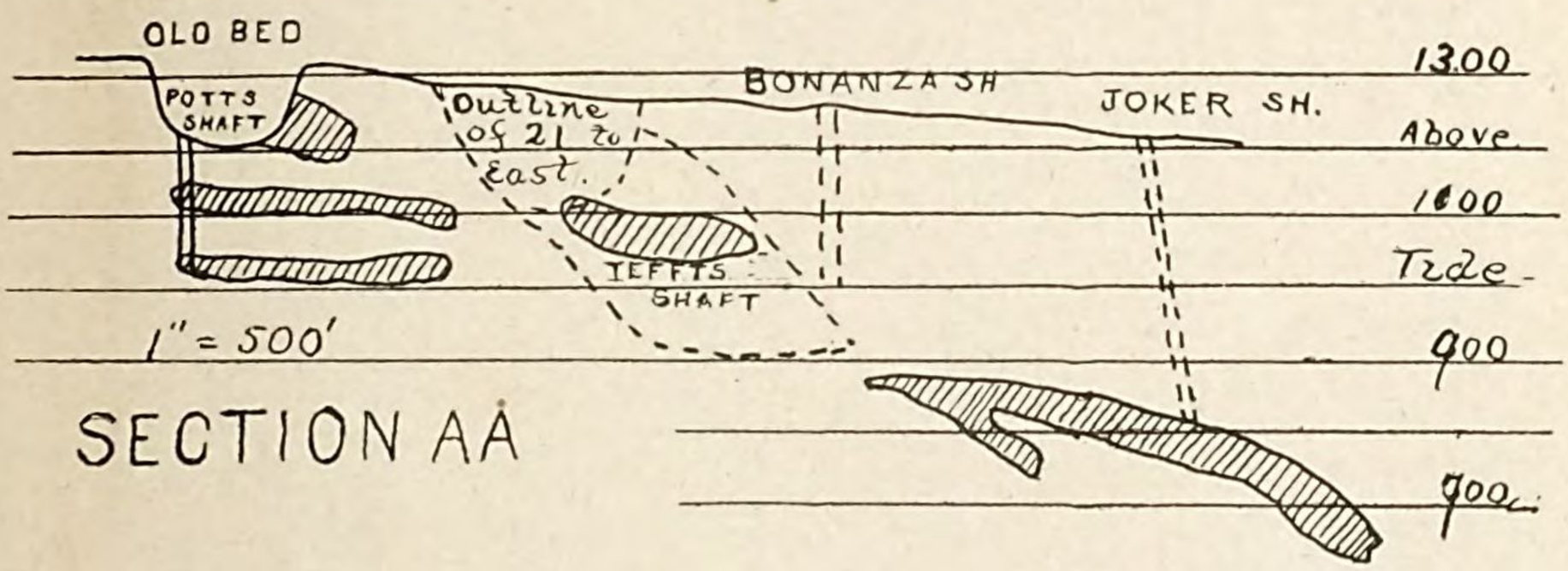
parallel to the banding, but their general shape, if indeed they have any uniformity, is far less clearly understood than that of the ores in gneiss as they have not yet been much mined.

## GENERAL FEATURES OF THE NON-TITANIFEROUS MAGNETITE ORE-BODIES

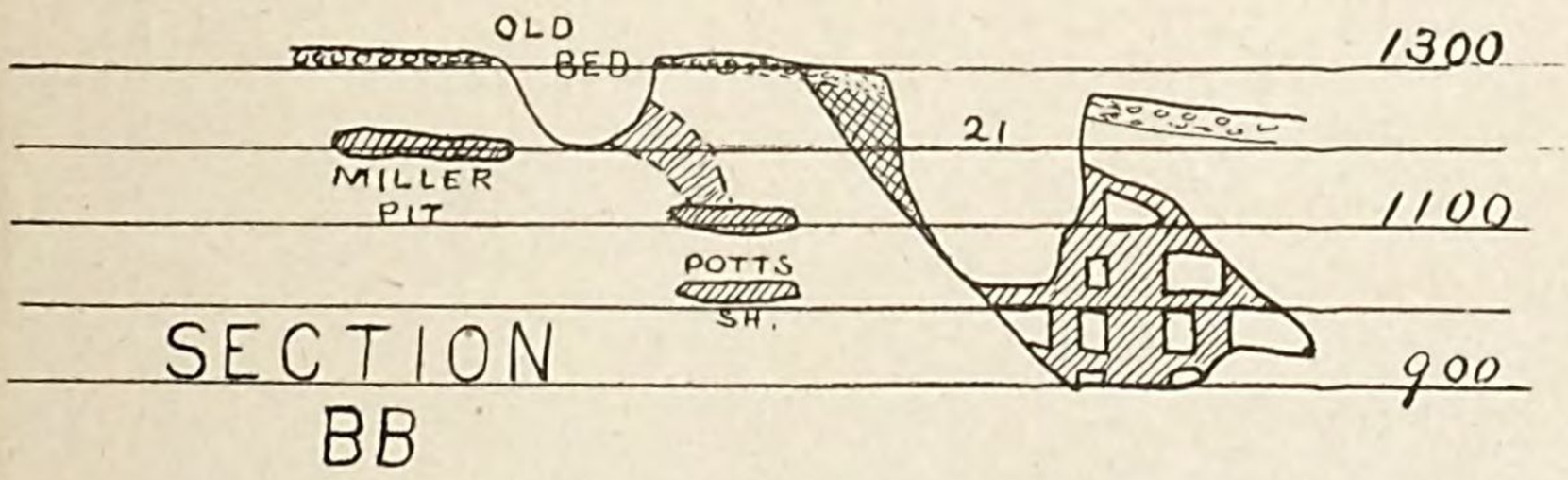
The common form assumed by non-titaniferous ore bodies, and the one usually associated with gneisses for wall-rock, is that of a bed or flattened lense, or pod, which lies parallel to the general foliation. They show no traces of having filled a cavity, but unless regarded as segregated veins, i. e. as having gathered along the bedding by the concentration of iron oxide from the walls, after the manner of a concretion on a grand scale, they must be considered true beds. For the smaller ore bodies in the two towns here described, these general relations and shapes hold good but for the great ore-bodies at Mineville, it is difficult to see how any folding and contortion of simple beds can explain the peculiar and irregular shapes which are later illustrated. They are decidedly abnormal. In the writer's estimation no segregative agency strictly so called could have occasioned them and some other method of origin must be invoked. The true lenses pinch, swell and feather out at the boundaries. They often fork when wedge-shaped masses of the walls come in. They are often distributed along a general horizon in the gneiss, although at times several beds, one over the other are afforded. The long axis of the ore-body does not run straight down on the dip, but diagonally, and this inclination is called the pitch in distinction to the true dip. The rule already formulated in New Jersey also holds good in the Adirondacks, that with a westerly dip the pitch is to the southwest, and with an easterly dip the pitch is northeast.

## DETAILED GEOLOGY OF THE IRON ORES

**The Mineville and Barton Hill Groups.** The topography of this district may be seen from the accompanying map. As already stated the Barton Hill group occurs at a higher horizon in the gneisses than the Mineville group, but just what it is in feet is hard to say, for there is a fold or crumpling between. As shown by the table the ores are contrasted in composition, the lower series being much higher in phosphorus. Almost no sulphur occurs in either, and titanium is insignificant.




SECTION AA




SECTION BB

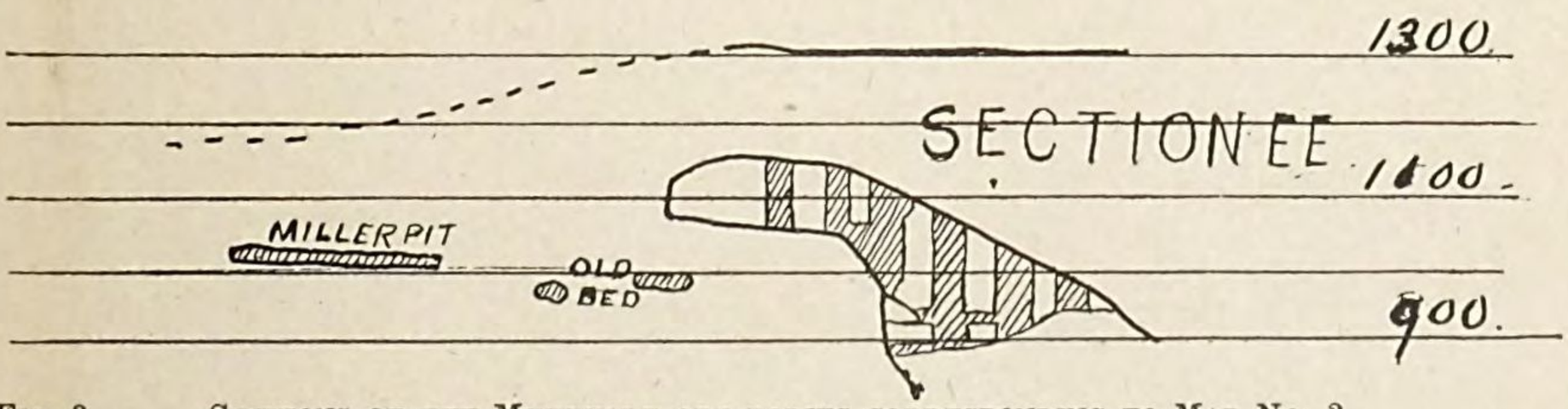
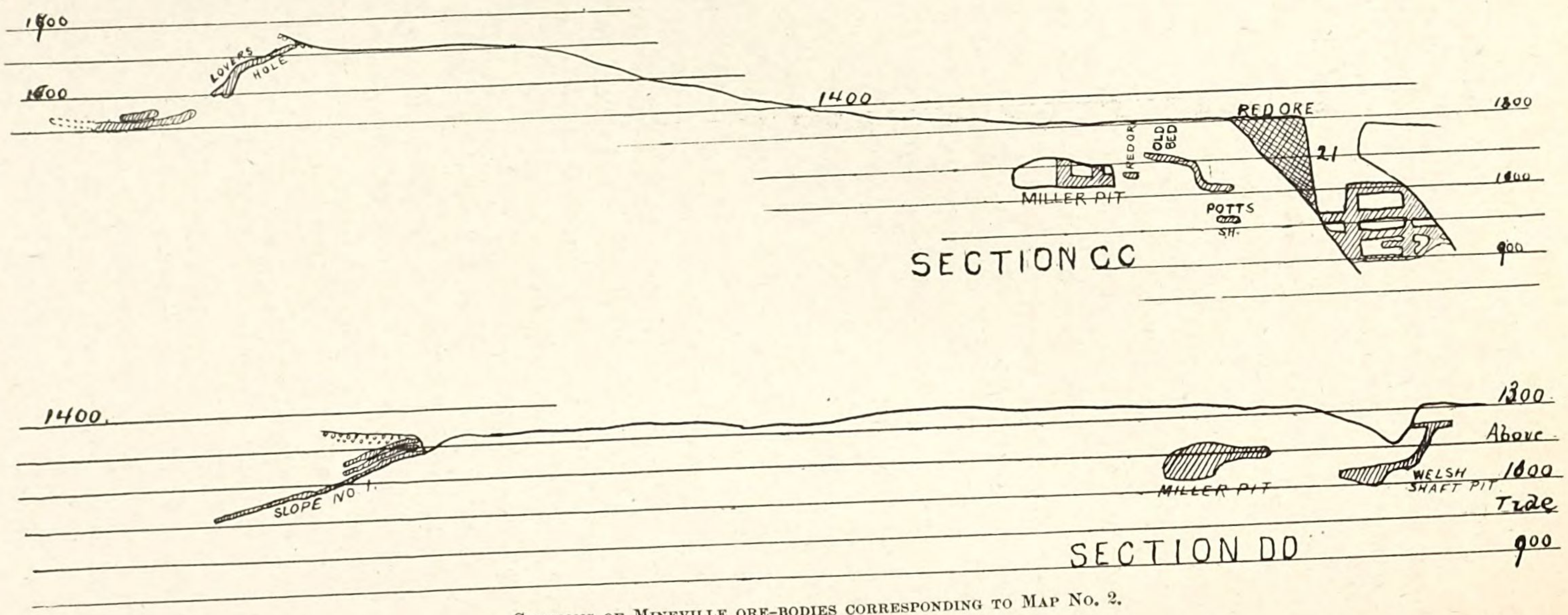



FIG. 3. SECTIONS OF THE MINEVILLE ORE-BODIES CORRESPONDING TO MAP NO. 2.




SECTIONS OF MINEVILLE ORE-BODIES CORRESPONDING TO MAP NO. 2.

FIG. 4.

The relations of the Mineville ore bodies have always proved confusing, but it is hoped that the accompanying sections may help to throw some light on them. Referring to the plan of the workings as shown on the map, it will be seen that the axial direction of all the ore bodies is southwest and that they lie in two or three parallel ranges. There are irregularities entering in that upset the uniformity of this somewhat, but in general it holds. There are five distinct mines. One is based on the bed, tapped by the Brinsmade and Welch shafts, and is generally called the Welch shaft bed. This dips westward at a varying angle that is nearly vertical at the north end and about 45° at the Welch shaft. In its southern part it runs in under the Old Bed (called in earlier days the Sanford) but a drift has been run through the intervening rock. The widest breast is about 50′ from wall to wall but at the northern end it pinches to an unworkable thinness. This bed appears in Section DD.

Lying over the last but also extending further south is the Old Bed. Old Bed has an axis that runs about S. 30 W. The pitch is quite flat being but 20°. The dip in the eastern workings is much more southerly than the Welch Shaft bed and on the western side it becomes more westerly. The Old Bed is quite complex in form and structure. It starts from the surface with a low dip, as already mentioned, but soon rolls over more and more steeply until it connects with a lower lying ore-body, which sets back under its upper portion, and is called the Potts Shaft bed, because opened by a shaft of that name. This same shaft tapped a still lower lying and parallel bed with which Old Bed also connects down the pitch. They are shown in Sections AA, BB, and CC. The structure can be best summed up, perhaps, as a triple forking of an original bed. The Old Bed, as do also the Miller and "21," thickens very much from a comparatively thin outcrop to a much greater section lower down. The mining has shown breasts varying from 20 to 125 feet. Mr Putnam of the Tenth Census referred this to the buckling of a sigmoid fold. He makes however no mention of the lower Potts shaft Bed and when this is included, the forking original seems more probable. The ore next the footwall in both Old Bed and 21 is specially charged with apatite. Indeed the workings in 1852 on the former were begun in order to procure phosphates for fertilizers. (W. P. Blake, Trans. Amer. Inst. Min. Eng. Balto. Meeting 1892.) Con-

siderable quantities have 10% or more of this mineral. This variety is called "red ore" and is of course avoided. This especial richness in apatite is interesting when compared with the investigations of D. H. Browne, on the distribution of phosphorus in the Ludington mine, Menominee District, Mich. (Trans. Amer. Inst. Min. Eng. XVII 616). Between the Old Bed and the Miller, there is a long pod of this red ore, which is separated from the Miller by a trap dike for its greatest part, but which runs into the Miller at its northern end.

The Miller bed has an axis that runs about S. 30 W, but it pitches at a higher angle than the Old Bed and in the northerly portion has a quite steep westerly dip, corresponding closely with the Welch Shaft bed. The inclination of the skipway is about 40°. To the southwest along the line of the axis it lies quite flat from east to west, but it has one notably steep drop on the pitch. This is indicated by the different altitudes of the several sections of this bed. Thus from DD to EE, it has pitched 200 feet, and a large part of this is in the one roll just mentioned. The breasts varied from 10 to 100 feet.

Mine 21 is the largest of all and has a magnificent ore body, 200–300 feet perpendicularly between walls. It has the general northwest course for its axis, while the pitch is not to be easily, if at all, determined. The dip varies from being nearly south and very flat in the Tefft shaft extension to an increasing steepness around to the eastward and to an increasingly eastward dip. The skipways, which are nearly parallel to the footwall, run down at about 60°. The ore body seems to lie on the southeast side of a doming anticline.

The fifth bed or mine is the Bonanza-Joker, lying south of the others, and not outcropping. It is an extension of "21," for the workings are now approaching each other and a hole has been bored through. (Section AA.) The axis of the Bonanza runs southwest as do the others. The bed is a double one, as it splits between the Bonanza and Joker shafts into two, over and under. A great horse of rock comes in, but each portion forms a noble ore body, the upper being 100′ thick and the lower 65′ as mined.

Still another thin ore body has been lately shown by the diamond drill south of the Joker, and a hole in the footwall of the Joker has revealed a vast additional thickness lying lower. The map with

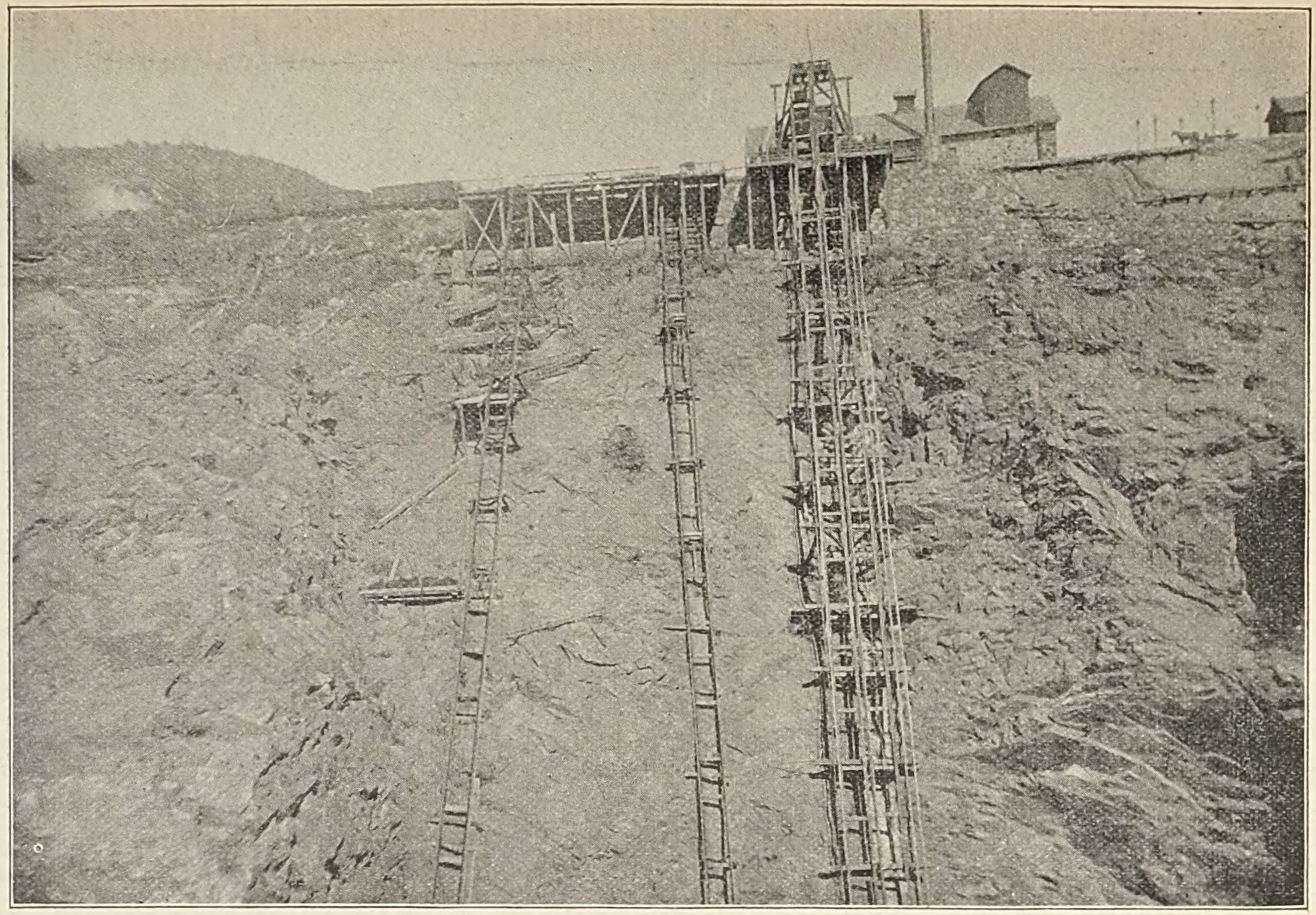


PLATE III

SKIPWAY INTO MINE 21, MINEVILLE, N. Y.

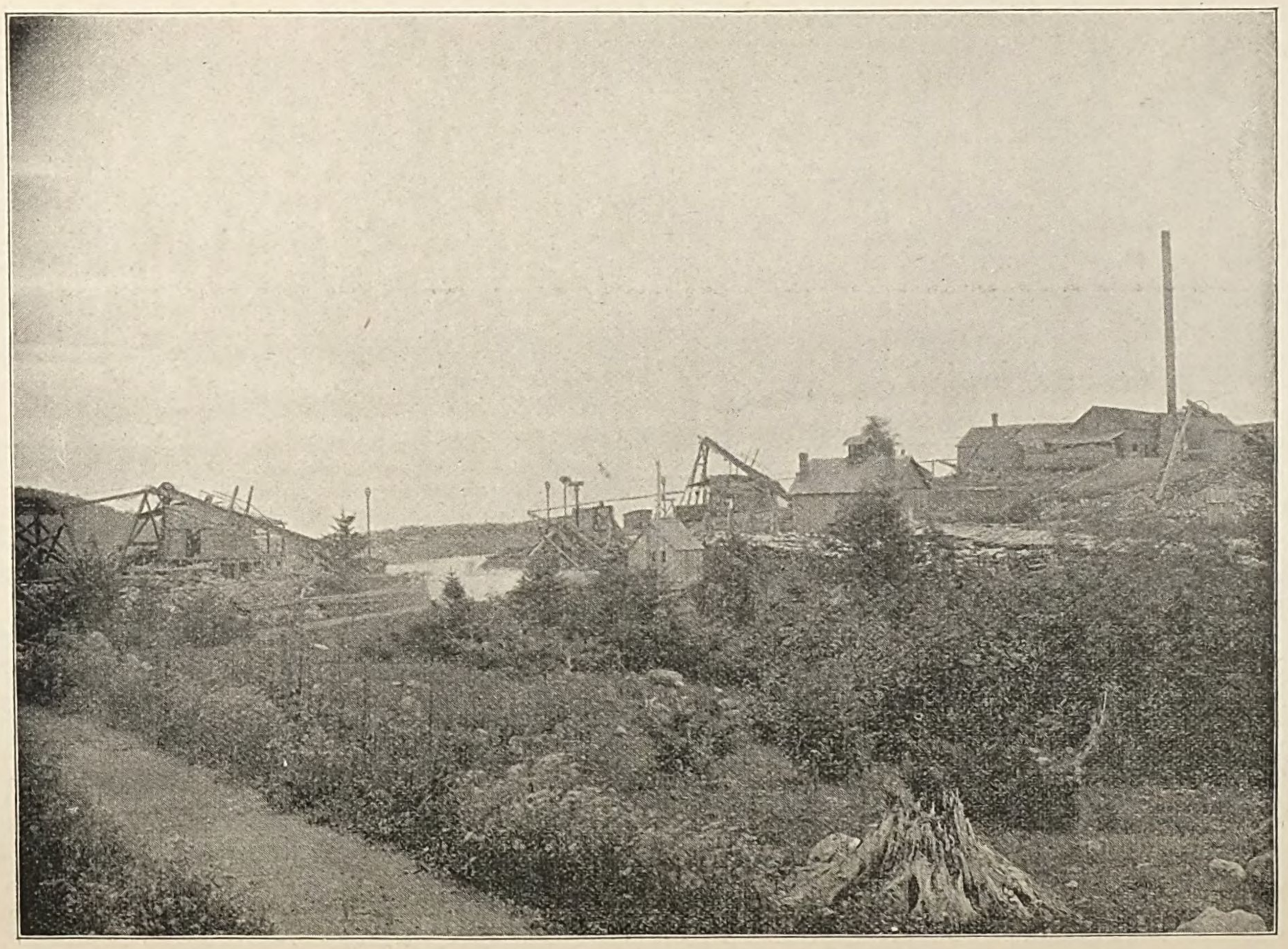


PLATE IV.

BURT LOT MINES NORTH OF BARTON HILL.
The two beds of ore are indicated by the skipways.

the outlines of the workings which are reduced from the surveys of Mr McKee, the engineer of the two companies, gives a clearer idea of the relations in plan than any description could and also of the surface topography. The sections will further afford a picture of the relation in elevation. They have been compiled from the most recent mine surveys (1893), but aid has been obtained from the drawings of Mr. Putnam (10th Census, v. 10, plate 27, p. 108) and from personal notes on the surface and underground. The important structural features are these: The westerly dip of the north ends of Welch shaft and Miller beds; the flat and more southerly dip of the Old Bed, of its several divisions and of the Miller; the southerly and easterly dip of "21." These facts indicate an anticline with a doming development in the easterly extension of "21." The forking of the bed makes it possible to have several of them one over the other. The Bonanza-Joker bed lies not far from the axis of this anticline on its southerly pitching crest, as does also Old Bed. The general southwest and somewhat parallel arrangement of all the beds or lenses is strongly shown in the map. Before the folding took place they doubtless all formed horizontal and parallel-tending, pod-shaped masses, and were afterwards heaved into their present position with some attendant faulting. The wall rock of "21," and some distance from the pit, is a light colored gneiss, consisting of microperthitic orthoclase, green augite, a little quartz and magnetite. The same rock also forms the summit of Barton Hill. It may be mentioned that the usual gneiss of the oldest formation contains biotite and some quartz but near the ores it becomes augitic. Microperthite is present in both. The strike of the gneiss is very irregular. Between the Miller Pit and Barton Hill readings were obtained varying from N. 10 E. to N. 85 E. with in one case N 60 W. The general average is about northeast. Section CC is drawn nearly across this strike. As indicated in the section the dip toward the Miller Pit is westerly but it changes to easterly and again toward the Barton Hill to the normal westerly.

In variety of minerals the mines are not prolific. Many years ago James Hall obtained from the Old Bed (called also the Sanford Bed) an unusually fine crystal of allanite which has been figured and described by E. S. Dana, (Amer. Jour. Sci. June 1884. 479).

In the office of Witherbee, Sherman & Co., at Mineville, there

are slabs with calcite, and one superb octahedron of magnetite, that is nearly symmetrical and perfect. A few quartz crystals also occur. The Barton Hill mines as later noted yield a greater variety.

**The Barton Hill Group.** The highest outcrop of ore at Barton Hill is as much as 400′ above the highest of the Mineville Group. Measured across the strike (Section CC) it is about 300′ between corresponding points, and there is at least 500′ of rock section in the interval. The dips show a fold to intervene, and allowing for this the distance 500′ is given. It is also possible that there is faulting and this is suggested by the steep slope of Barton Hill, resembling as it does a fault-scarp. The outcrop of the beds at Barton Hill is long, being over $\frac{3}{4}$ of a mile. It is shaded in on the map. The general southeasterly pitch for the axes of the lenses is also well shown by the map and is notably parallel to those of the Mineville group.

This belt has been exploited over nearly the whole of the outcrop but all the output is not equally good. The deepest workings are at the New Bed where the slope has followed the chute down over 2000 ft. The beds are not as thick as in the Mineville Group. They range about 8′, with 20′ as a maximum, and are quite irregular. In places three beds have been met, as at the New Bed. The Lovers Hole exposed but two but one was very thin, (See Figure in paper by Mr John Birkinbine, Crystalline Magnetite in Port Henry Mines, Trans. Amer. Inst. Min. Eng. Feb. 190. Vol. XVIII), and the other thickened to a large body of extraordinarily pure and rich ore. 40,000 tons of the run of the mine gave 68.6 Fe. As the map shows, the workings are quite irregular all along the belt and much exploration is necessary to keep them well in hand. The continuation to the north appears to be broken beyond the Little Orchard Slope, and a barren piece comes in. The ore, doubtless from the same belt, reappears in the Fisher Hill Mines and their northerly extension, the Burt Lot. In the last named there are two beds separated by about 50 ft. vertical thickness of rock, although much more across the surface from slope to slope, as the dips are flat. The dip at Fisher Hill is about 25° southwest as measured on the skipway. This flattens out in the northerly openings to 22°.

In the Burt Lot Mines the dip is about 25°. These latter are in Elizabethtown. The break between Barton Hill and Fisher Hill may be due to a fault or eroded fold, but the lack of outcrops pre-

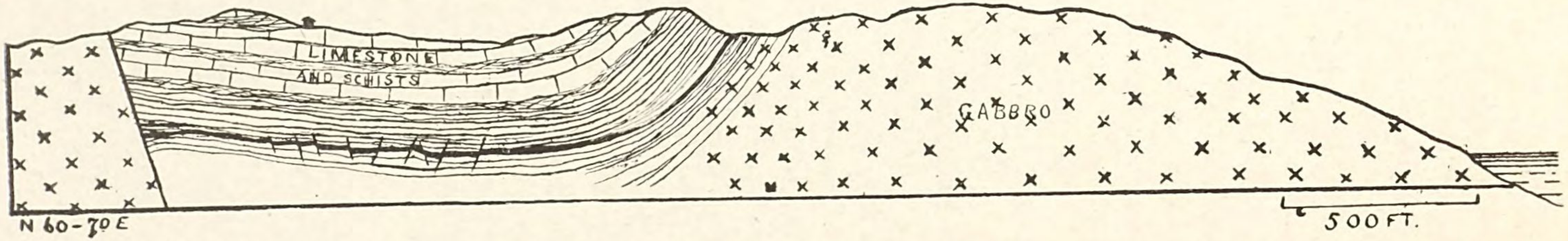



FIG. 5. CROSS-SECTION OF THE CHEEVER MINE

vents observation. The belt continues beyond the New Bed to the south, as recent drilling has tapped it.

In this section, the wall rock near the ore at the Lovers Hole, is seen to contain plagioclase and orthoclase, brown biotite, green hornblende, titanite, zircon and magnetite and is an ordinary quartzless gneiss. A specimen from the top of Barton Hill was shown by the same form of examination to contain quartz, microperthitic orthoclase in great amount, diallage and hornblende, being very like the rock mentioned above as occurring near "21." These rocks are all gneisses that often but not always become more basic toward the ore body. Sections from the wall rock at Fisher Hill and the Burt Lot mines are practically the same.

Along with the ore or near it in the wall rock, are at times masses of very hornblendic rock. When cracked open these occasionally show small zircons, apatites and very fair titanite crystals.

At the South Pit some excellent red garnets up to 1″ in diameter have been brought to light, in talcose or chloritic material. They were very brittle and crumbled with slight rubbing.

The Lovers Hole pit has also yielded considerable fluorite, which, of white, red and green colors, gave rather fine specimens. It had more or less magnetite disseminated through it. It was probably from a small vein-filling or in part a replacement of the gneiss.

Fine cleavage pieces of plagioclase are also to be had on the dumps. The beautifully striated surfaces contain at times several square inches.

**The Pilfershire and Pease Pits.** These are now abandoned. They lie along the westerly foot of the range of gneissic hills that separate Mineville and Moriah Center from the lake. Both mines are now full of water. They strike a little west of north and dip 50° to 60° west. The gneiss just to the south of them contains quartz, microcline, orthoclase, very little plagioclase, emerald green pyroxene, and a little magnetite. The lean ore in thin section exhibits magnetite, light green pyroxene and apatite. As elsewhere the gneiss is more basic near the ore.

**The Lee Mine.** This is just back of Port Henry and in gneiss immediately west of the ophicalcite exposures. The outcrop of ore is in a small steep hill on the west side of the fault figured on the map. The strike at the main opening is west of north and the dip at the skipway is 19° W. Mr Putnam (10th Census Vol. X. p. 115)

states that the ore is cut off on the north by a trap dike. The ore is pyritous and is no longer mined. The breast was 8–10 ft. The hanging wall is gneiss and contains microperthitic orthoclase, quartz, green biotite, magnetite and pyrite.

**The Cheever Mine.** A general section of the Cheever ore body is here given. The mine is situated about two miles north of Port Henry, but the ore belt is prolonged about a mile further in a northerly direction, the Goff mine being in this portion. The Cheever is one of the most interesting of all in its geology, and for this reason the geological section has been prepared based on the outline of the ore body given by Mr Putnam (10th Census Vol. X. p. 113). The upper topography is reproduced from the 20 ft. contour map of the U. S. Geol. Survey and from sketches made on the ground. The section shows that the ore has over it gray feldspathic gneiss 25′ containing green pyroxene, plagioclase, quartz and orthoclase. The lean ore consists of magnetite with some green pyroxene and some plagioclase.

The next 15′ is hornblendic gneiss, containing quartz, microperthite, plagioclase, orthoclase, brown hornblende, green pyroxene, garnet and apatite. Fifty yards from the ore is gray gneiss again, with quartz, microperthitic orthoclase, brown biotite, very little plagioclase, and magnetite. Over this lies black hornblendic schist and white crystalline limestone. Under the ore is gneiss again but 50 feet east of the ore body, foliated gabbro appears consisting of bastite, brown hornblende, and plagioclase represented by a saussuritic alteration product. The bastite is a light yellow, feebly pleochroic, brightly polarizing mineral, very fibrous and with extinctions parallel to the fibres. In the longitudinal sections it shows the trace of a biaxial figure, but in one transverse section a rectangular cleavage still remained with diagonal extinctions. This would suggest diallage as the original of it. A few garnets are also present. A little further the gabbro becomes massive, and contains hypersthene, brown hornblende, magnetite, much garnet and shattered and saussuritic plagioclase. The gabbro extends to the lake. To the west the ore is cut off by a fault, the underlying gabbro being heaved up along the west side. The ore is also cut by several trap dikes all of the diabase type, which upset it short distances. The ore body is not one single continuous bed, but splits at times into two from incoming horses.

It is much narrower than long, and has the usual lenticular cross-section forming a great pod or elongated lense, with its axis running about S. 60 W, thus showing the invariable southwest pitch with a westerly dip. Two cross sections are given by Putnam, who made them underground. At my visit the mine was full of water. Borings across the gulch to the south have shown a thin bed at 300′ depth. The geology of this ore body presents points of interest not shown by others. At first sight it might appear like a great contact deposit near the junction of gabbro and limestone, but so much gneiss intervenes that difficulties are in the way of this view, and the shape, structure, associates and character of the ore all connect it with the usual lenses in the gneiss. It lies however in the gneiss near the overlying limestone, and also near the intruded gabbro. It differs from the ores in the gabbro by having but slight traces of titanic oxide. The general composition is very much like that of the Mineville ores.

## Other Mines in Moriah

The county atlas mentions an opening near the house of James Lewis, and inquiry of Mr Lewis elicited the fact that he believes that he has opened a large ore body. I did not visit the openings, but specimens gathered from the hill in the rear of his house are gneissoid gabbro, and if in these rocks the ore would prove titaniferous. There is also an old series of prospect holes two miles or so south of Lewis's. These show traces of ore but nothing serious. The wall is gneiss and consists of orthoclase, green pyroxene, much titanite and a little hornblende. A small prospect has been ill-advisedly run in on a fine diabase dike, on the east side of a hill a mile west of Moriah Center. A considerable plant has been set up at the Coat Hill Mines, on Bullwagga Mtn. Both walls and ore consist of crushed quartzes, chloritic matter, rotten feldspar and scattered magnetite grains. There are no surface indications of any ore body of serious moment.

**General Remarks.** The present state of the iron business and the small prices at which Lake Superior ores are now sold in the east offer slight encouragement to new ventures. The productive ones do however occur along common lines of strike, and any prospecting would best be done with these as ranges. Disturbances of strike and dip should however be looked for with care, as in such a

broken region, they are common and might throw one off the track. As already mentioned cross gulches are often caused by faults.

**Iron Mines of Westport.** There are at present no producing mines in Westport, and such as have been opened have been idle for many years. Except perhaps the second bed at Nichols Pond all that we visited were clearly in the gabbro series and gave thus every reason to infer that they are titaniferous and such analyses as have been available, have carried out this impression.

**The Nichols Pond Mines.** These are situated high up on a mountainous ridge, above Lake Champlain, and just north of Nichols Pond. There are two beds; the southerly one is in gneissic gabbro, and is about 9′ thick. It strikes nearly East and West, and dips south about 80°. The ore is magnetite mixed with hornblende and is lean. The second bed lies more to the north, and shows the following section, with a strike and dip like the last. 1, Hanging wall gneiss. 2, Ore 12′–15′, shot ore consisting of magnetite and quartz. 3, Lean Ore not worth separating 20′, but of same general character as 2. 4, Compact feldspathic rock, 15′. 5, Lean shot ore and quartz same character as 2, not worked. 6 Foot wall coarse gneiss. There was a large separator in operation some 25 years ago at Nichols Pond, and a tramway ballasted with tailings runs down to the highway to the eastward. As stated by Professor Smock, (Bull. N. Y. State Mus. No. 7. p. 36) these mines are in lots 166 and 168 of the Iron Ore Tract and on Campbell Hill.

**The Ledge Hill Mines.** This name may not be the most common or correct one, but it is the one given us in Westport. The mines are near the summit of a hill, two miles west of Westport and are several hundred feet above Lake Champlain. They are in gabbro of a gneissic habit, but at times quite massive at points not far from the ore. There are two ore bodies. The ore is richest in the middle and becomes lean towards the walls, with abundant hornblende and garnets. In the lowest opening there are 4′–6′ of richest ore. Fifty feet higher up there is another opening on the same ore. The strike is east of north and the dip is high to the west. A little to the east is a second ore body, opened by a cut about 6′ feet wide at the bottom. The walls are gabbro. The mines are in lot 163 of the Iron Ore Tract.

**The Split Rock Mines.** These are opened in Split Rock

Mtn., about 100 feet above Lake Champlain, and show very considerable excavations, which are practically dry, as the situation for mining is very convenient. The ore is 10′ thick, strikes N. 70–80° E. and dips 50° south. Gabbro forms the walls right up to the ore on both sides. It is the metamorphosed variety with the copious reaction runs of garnets. The writer was told that there is another opening to the south. There is a separator on a level with the lake, and above the mines, in a terrace in a break in the hills, are the old boarding houses. From this terrace there is a most superb view of the lake and the Green Mountains. The mine is just across from Fort Cassin. The analysis of the ores given in the opening table shows that they contain from 13–16 $TiO_2$ with 32.5 to 44.7 Fe.

## GENERAL REMARKS

There seems little if any prospect of profitable mines in Westport in the future. Those ores that are reasonably near the lake are certainly titaniferous and cannot be used under the present calculation of blast furnace slags and mixtures. The non-titaniferous ores which may be in the western limits of the town, are extremely inaccessible if indeed in any quantity.

In their scientific relations the titaniferous ores are of great interest. They invariably occur in dark, basic gabbros and in such relations as to make the inference unavoidable, that they are excessively ferruginous or basic, portions of the original igneous magma. There is no sharp line of demarcation between ore and wall but a gradual passage of one into the other, although in a short space. We are coming to recognize titaniferous magnetites in these relations in many parts of the world, and Wadsworth* in this country, Derby† in Brazil, and Vogt‡ in Sweden have already called attention to such.

---

*M. E. Wadsworth. The Iron Ore or Peridotite of Mine Hill, Cumberland, R. I. Bull. Min. Comp. Zool. 1880. VII.

†O. A. Derby. Magnetite Ore Districts of Jacupiranga and Ipanema. Sao Paulo, Brazil. Amer. Jour. Sci., April, 1891. 311.

‡J. H. L. Vogt. Bildung von Erzlagerstätten durch Differentiations-processe in basischen Eruptivmagmata; Zeitschrift für praktische Geologie, I. pp 4, 125, 257. This paper appears in its completest and latest form in the reference given, although the conclusions had been previously published elsewhere.

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ELIZABETHTOWN

WILLSBORO

ELIZABETHTOWN

WADHAMS MILLS

SPLIT ROCK MINE
Ore
Spec 236-241

WESTPORT

LAKE LEVEL

BARBERS POINT

COLES BAY

ROUGET RIVER

BLACK RIVER

NICHOLS PD

LINCOLN POND

MINERVILLE

MORIAH CENTER

PORT HENRY

CEDAR PT.

CROWN PT

CHEEVER DOCK
9-10-11-12

156-172.
Cheever mine

PROBABLE FAULT

Str. N. 30 E

Str. N. 45 W

Str. N. 40 W

Str. N. 45 W.

Str. N. 55 W.

Str. N. 40 W

Str. N. 40 E

GNEISS

CRYSTALLINE LIMESTONE AND BLACK SCHISTS

ANORTHOSITE

GABBRO

CAMBRIAN. POTSDAM SAND

LOWER SILURIAN LIMESTONE
CALCIF.
CHAZY
TRENTON.

GLACIAL GRAVELS ETC.

SCALE OF MILES

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# I. Geological Map of Moriah and Westport Townships, Essex Co. New York

BY J. F. KEMP


NORTH

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Division 1 De Kay, J. E. Zoology. 5 v. pl. 1842–44.
" 2 Torrey, John. Botany. 2 v. 1843.
" 3 Beck, L. C. Mineralogy. 24+536p. il. pl. 1842.
" 4 Mather, W: W.; Emmons, Ebenezer; Vanuxem, Lardner; and Hall, James. Geology. 4 v. pl. maps. 1842–43.
" 5 Emmons, Ebenezer. Agriculture. 5 v. il. maps. 1846–54.

**Division 6 Paleontology.** Hall, James. Palæontology of New York. il. pl. sq. Q. Albany 1847 — date. *Bound in cloth.*

v. 1 Organic remains of the lower division of the New York system. 23+338p. 99 pl. 1847. *Out of print.*

v. 2 Organic remains of the lower middle division of the New York system. 8+362p. 104 pl. 1852. *Out of print.*

v. 3 Organic remains of the Lower Helderberg group and the Oriskany sandstone. pt. 1, text. 12+532p. 1859. *Price* [$3.50.]

——— ——— pt. 2, 143 plates. 1861. *Price* $2.50.

v. 4 Fossil brachiopoda of the Upper Helderberg, Hamilton, Portage and the Chemung groups. 11+1+428p. 69 pl. 1867. *Price* $2.50.

v. 5, pt. 1 Lamellibranchiata 1. Monomyaria of the Upper Helderberg, Hamilton and Chemung groups. 18+268p. 45 pl. 1884. *Price* $2.50.

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——— pt. 2. Gasteropoda, pteropoda and cephalopoda of the Upper Helderberg, Hamilton, Portage and Chemung groups. 2 v. 1879. v. 1, text, 15+492p. v. 2, 120 plates. *Price* $2.50 *for* 2 *v.*

v. 6 Corals and bryozoa of the Lower and Upper Helderberg and Hamilton groups. 24+298p. 67 pl. 1887. *Price* $2.50.

v. 7 Trilobites and other crustacea of the Oriskany, Upper Helderberg, Hamilton, Portage, Chemung and Catskill groups. 64+236p. 46 pl. 1888. Cont. supplement to v. 5, pt. 2. Pteropoda, cephalopoda and annelida. 42p. 18 pl. 1888. *Price* $2.50.

v. 8, pt. 1 Introduction to the study of the genera of the paleozoic brachiopoda. *Price* $2.50.

——— pt. 2. *In progress.*

Il. nat. 95 Fb 8.

University of the State of New York

# BULLETIN

OF THE

# New York State Museum

Vol. 3 No. 15

September 1895

# MINERAL RESOURCES

OF

# NEW YORK STATE

BY

FREDERICK J. H. MERRILL, Ph. D.,

Director New York State Museum

ALBANY

UNIVERSITY OF THE STATE OF NEW YORK

1895

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# PREFACE.

This bulletin is in part the outgrowth of the work done in preparation for the Scientific Exhibit of New York at the World's Columbian Exposition. In collecting a representative series of specimens of the economic products of the State much information was obtained concerning the various mineral deposits. As sufficient space was not available in the text of the report of the Superintendent of the Scientific Exhibit to discuss fully the data at hand, and as it was necessary that the economic and geologic map should be accompanied by a description of the various economic minerals and their relations, it seemed advisable to prepare a bulletin containing a synopsis of the facts. This bulletin is designed to answer many questions concerning the mineral resources of New York which have hitherto been answered by correspondence, and though it is not offered as an entirely complete record, it is hoped that it may in a measure supply a want which has long been manifest and that in a future revised edition it may be made more perfect. In the brief time available for the preparation of the bulletin it has not been possible to write original articles on all the economic minerals of the State. Extracts have, therefore, been made from various reliable articles already in print wherever it seemed advisable to use them, and references are given to other literature.

FREDERICK J. H. MERRILL.

ALBANY, *March*, 1895.

# Economic and Geologic Map.

The map which accompanies this bulletin was prepared to illustrate the report of the Superintendent of the Scientific Exhibit of the State of New York at the World's Columbian Exposition and is intended to show the distribution of the principal mineral deposits which are of economic value.

As a geologic base was necessary to the proper differentiation of the formations which are of economic importance, and as no geologic map of New York had been published since 1844, the want could only be supplied by the compilation of a new one. Since but little time was available for this purpose, in consequence of the fact that the report on the Exhibits of New York at the World's Fair was already in press when the Superintendent was asked to contribute the map, it is not to be expected that errors have been entirely avoided, and the incomplete state of geologic knowledge has left many gaps which in the present map have been filled by inference, but the belief that this map will be of practical use to teachers, students and business men throughout the State leads the author to publish it without prolonged apology for unavoidable inaccuracies. Those who wish for more minute information concerning the distribution of the geologic formations of New York are referred to the new geologic map of the State now in preparation by the State Geologist, Prof. James Hall. This will be on a very much larger scale and will show more clearly and accurately the geologic detail.

The work of preparing the geologic base for the economic map has brought to light serious deficiencies in our knowledge of the geologic formations of New York State.

Although New York is the mother state in geologic nomenclature and contains a more complete and extensive series of the formations below the carboniferous than any other state, and although the rocks have been studied for more than sixty years by professional geologists and students, our recorded knowledge

of geologic detail is far from complete. This is especially true of the Pre-cambrian formations which consist of metamorphic and igneous rocks. This is not, however, very remarkable when we consider that accurate methods of rock study and classification have had their greatest development since 1873, when through the labors of Zirkel and Rosenbusch the microscope was successfully applied to the study of rocks. In mapping the Pre-cambrian formations of New York the author is, therefore, unable to give any great amount of detail. In Westchester, Putnam and southern Dutchess counties his personal studies during a number of years, with the assistance of Messrs. E. M. Blake and H. Ries, have enabled him to differentiate the areas of metamorphosed palæozoic limestones and schists from the subjacent gneisses which can be traced northward through Westchester county and are apparently continuous with the banded gneisses which rest upon the granite of Putnam county. The small scale of the map makes it impossible to show the full detail of these narrow belts of rock which owe their existence to the folding and erosion which has taken place within that region. Within the Pre-cambrian area of Putnam county, which is generally known as the "Highlands," in addition to the banded gneisses which contain the beds of magnetite, there are large masses of granite which appear along the axes of the mountain folds, being flanked by the gneisses. The author regards these as igneous granites made plastic in the process of mountain making which created the folds in which they occur. No attempt has been made to differentiate these granites in the mapping, nor has any field work been undertaken with this end in view. The southwestern extension of this Pre-cambrian area through Rockland and Orange counties into New Jersey has precisely the same component rocks and structure. Besides the "Highlands" Pre-cambrian area just mentioned, there is the greater area of the Adirondack wilderness. This is known to include two principal formations of Pre-cambrian age. First, an area of metamorphic rocks, extending from Lake Champlain to the Black river and from southern Fulton county nearly to the Canadian boundary. Secondly, in the eastern part of the wilderness and touching at two points the shore of Lake Champlain is a mass of basic plutonic rock chiefly composed of hyper-

sthene and labradorite which may be called norite. In the work of the original Natural History Survey of New York, which culminated in the publication of the reports on the four geological districts of the State in 1842 and 1843, this region was investigated by Prof. Ebenezer Emmons. This geologist recognized clearly the striking lithological difference between the massive norite and the stratified gneisses which envi-roned it, but gave no accurate description of their boundaries, doubtless for want of an accurate map of the wilderness. In 1883 a map of Essex county by C. E. Hall was published in the annual report of the State Geologist, which gives approximately the boundaries between the norite and the gneisses. In 1892 Prof. J. F. Kemp, of Columbia College, undertook the study of Essex county under the auspices of the State Museum, and the results of his work are embodied in the economic map.* While Prof. Kemp's observations have not been carried around the whole periphery of the plutonic mass, they go sufficiently far to show that it occupies but a small part of the Adirondack wilderness and can be included in a circle of about fifty miles diameter, with its center in the vicinity of Keene Valley. Within this plutonic area are the principal peaks of the Adirondack mountain group. The extension of this area into Franklin county as shown on the map is based on the observations of Ebenezer Emmons. The northwestern part of the metamorphic area is believed by Prof. James Hall to contain rocks of Huronian age. The study of this region is now in the hands of Prof. C. H. Smyth, Jr., of Hamilton College, and to him we look for the elucidation of this question. He classifies under the name of Oswegatchie series a group of crystalline limestones and gneisses. The geology of the Adirondack region as given in the map is based upon the original work of Ebenezer Emmons and Lardner Vanuxem with additions by C. E Hall, J. F. Kemp and T. G. White in Essex county, and by F. J. H. Merrill in Warren and Hamilton counties. In St. Lawrence, Jefferson and Lewis counties Prof. Smyth has given information cencerning the distribution of the gneisses and other Precambrian rocks. On the north side of the wilderness Prof. H. P. Cushing, of Adelbert College, Cleveland, Ohio, has been conducting some field work and has revised the lower boundary of

*See also Bull. No. 13. N. Y. State Museum.

the Potsdam in Clinton county. An examination of the shores of Lake George was made for the Museum in 1891 by Mr. E. M. Blake.

From the base of the palæozoic upward the geologic formations of New York were quite accurately studied in the original survey, but the work of mapping the boundaries was not very carefully done, and though at the present time there is much new information in the possession of those who have made special studies of these formations, but little new material has been published, and it has not been possible within the time at the author's disposal to consult those in possession of unpublished material. The author's personal observations on the palæozoic groups have been chiefly confined to the upper and lower Helderberg limestones and the strata immediately adjacent to them, in Greene, Albany and Schoharie counties and at various points to the westward along the principal lines of railway. The principal guide used in the preparation of the geologic base was the Agricultural and Geological map of New York, published by authority of the Legislature in 1844. In revising the boundaries given on this map the four geologic district reports of New York have been carefully studied, and from them many corrections have been introduced, although the old map was based on the material contained in those reports. This was particularly noticeable in mapping the outcrop of the upper Helderberg limestones, which on the old map is shown far to the northward of Otsego and Schuyler lakes, although Vanuxem reported the occurrence of the corniferous limestone at Richfield Springs, in the town of Springfield at the head of Otsego lake and at Cherry Valley; a similar error occurs in the mapping of these limestones in Seneca county, where they are shown in a straight belt between Seneca and Cayuga lakes, far to the south of Seneca outlet, although Prof. James Hall reported the occurrence of the upper Helderberg limestone on Seneca outlet west of Waterloo. In the new map the two Helderberg limestones have not been differentiated for three reasons: First, because the scale of the map was too small to permit it; second, because the author had not sufficiently accurate information to enable him to separate them, and, third, because the map, being chiefly economic, it seemed best to represent the two limestones

in one belt. The boundary between the Hamilton and Portage group accords very nearly with the views of Prof. C. S. Prosser.

In addition to the text of the reports, the following published maps have been consulted :

Geologic maps of Jefferson and Clinton counties, by E. Emmons, Natural History of New York, Report on the Geology of the Third District, 1842; a geologic map of Ontario county, by J. M. Clarke, Report of the State Geologist for 1885; a geologic map of Yates county, by B. H. Wright, Thirty-fifth Annual Report of the New York State Museum, 1881; a geologic map of Onondaga county, by Geo. Geddes, Report of the New York State Agricultural Society, 1859; a sketch map of the Mohawk Valley, by James Hall, Report of the State Geologist for 1885; a geologic map of Washington, Rensselaer and Columbia counties, by C. D. Walcott, American Journal of Science, vol. 35, p. 399; geological maps of parts of Dutchess and Columbia counties, by J. D. Dana and W. B. Dwight, American Journal of Science, a geologic map of parts of Orange and Ulster counties, by John C. Smock, part of geologic map of New Jersey, 1868; a map of Richmond county, by N. L. Britton, Annals of New York Academy of Sciences, vol. 2, revised by C. A. Hollick. The work of T. Nelson Dale, in Rensselaer county, Thirteenth Annual Report Director United States Geological Survey, has also been used. McFarlane's Geological Railway Guide has been freely consulted. To Prof. James Hall, State Geologist, the thanks of the author are due for information concerning the geology of many localities.

To the second edition of the map Prof. Dwight has contributed an original map of Dutchess county, and Profs. H. L. Fairchild and P. H. Hargitt have respectively contributed to the geology of Rochester and Syracuse.

Mr. N. H. Darton's work in Ulster county, published in the Report of the State Geologist for 1893 has also been used.

The localities of iron mines are chiefly taken from the map of Prof. J. C. Smock.* The stone quarries are chiefly from Prof. Smock's map,† with additions by Wm. G. Eberhard, E. M., and

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* Bulletin of the New York State Museum, No. 7.

† Bulletin of the New York State Museum, No. 10.

Wm. C. Clarke, E. M. The clay localities were mapped by Mr. Heinrich Ries,* the oil pools by Messrs. C. A. Ashburner and D. Van Ingen, the salt wells by R. D. White, Jr., C. E., and the gypsum quarries by Wm. C. Clarke, E. M. The other mineral localities were mapped by the author.

In preparing the base, various practical difficulties had to be met. Among these were the lack of accurate information concerning the boundaries of the Chemung and Catskill formations in New York, the impossibility of undertaking any new field work, and the lack of sufficient funds to permit of more than fifteen printings in the press work of the map. It has, therefore, been necessary to emphasize the economic character of the map rather than the geologic character, to associate in color, rocks of similar economic or lithologic features, and for lack of information and funds for printing, to indicate without differentiation the great mass of sandstones, shales and conglomerates included between the base of the Portage and the top of the Catskill.

When the large geologic map of New York, now in preparation by the State Geologist, is published and distributed, there will be a definite expression of opinion on the boundaries of these formations, but at present there is no official presentation of the subject.

The map will be found in the pocket of the cover of the bulletin and the legend will explain the various tints and symbols used.

### Geologic Map of Westchester and New York Counties.

Since the scale of the State economic map is not sufficiently large to give in detail the areas of building stone, in New York and Westchester counties, a map of that region is published on a scale of four miles to one inch. This map is based on the studies of the author and shows the present state of geologic knowledge in that region.

### Economic Minerals of New York.

Under this head are described the minerals of New York which are commercially important. So far as possible a directory of the producers has been prepared for each mineral product.

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* Bulletin of the New York State Museum, No. 12.

References are given to the literature of the various materials which have been fully described in other publications, and in some cases abstracts have been made from reliable authorities. Wherever new information is at the disposal of the author a brief synopsis of it is given.

It was originally hoped that statistics of the production of the various minerals could be given, but this project was abandoned because it involved more labor and expense than was possible up to the time of publication.

# Building Stone

This important class of material has been discussed at length by Prof. John C. Smock in Bulletins Nos. 3 and 10 of the New York State Museum, and these two publications contain nearly all that is known at present.

Since Bulletin No. 10 is out of print a large portion of it has been incorporated in the following pages.

The directory of producers gives the latest information.

## GEOLOGY AND GEOGRAPHIC DISTRIBUTION OF BUILDING STONE IN NEW YORK.

By John C. Smock. Revised by F. J. H. Merrill.

### GRANITIC ROCKS

#### Granites, Gneisses, Syenites, Trap-Rock and Norites.

**Granites.** Typical granite is a crystalline, granular mixture of feldspar, quartz and hornblende. In addition to these essential constituents, one or more accessory minerals may be present. The more common are the micas, muscovite and biotite, garnet, tourmaline, magnetite and pyrite. The character of the rock is often determined by the presence of these accessory constituents in quantity, as in some cases the hornblende is entirely replaced by mica.

The chemical composition also varies from that of the average or typical kind. The mineralogical differences mark the varieties, thus there are: hornblende granite, biotite granite, tourmaline granite, etc.

The texture of granites is determined by the aggregated minerals entering into their composition. They vary from coarse-crystalline, in which the individual crystals may be an inch or more in length, to fine-crystalline and aphanitic, wherein the minerals are hardly visible to the eye. In consequence of the wide variation due to the mode of arrangement of the

mineral constituents, there is an equally great variety noticeable in the texture.

The color also is dependent upon the minerals. As feldspar is the predominant constituent it gives character to the mass, and the red varieties owe their color to the red or pink feldspars in them, as in the case of the granite of Grindstone Island in the St. Lawrence. The shades of gray are due to the varying amount of the dark-colored mica mixed with the feldspar and quartz; and the darker-colored varieties owe their color, in most cases, to hornblende or tourmaline which may be present.

The beauty, ease of working, durability and value of the granites for use in construction is related closely to their mineralogical composition. Their arrangement in the mass and their relative proportion determine the color and give beauty. The presence or absence of certain species influence the hardness and homogeneous nature and the consequent ease with which the stone can be dressed and polished. For example the mica, if disposed in parallel surfaces, gives a foliated structure and tends to produce what is known as rift, and the granite is more readily split in the planes of the mica than across them. Again the mica flakes may be so large and irregularly massed that the surface is not susceptible of a uniform degree of polish. Hornblende, on account of its superior toughness, is less brittle than pyroxene under the polishing, and the hornblende granites are said to be preferred to those rocks which contain pyroxene in quantity.

The more nearly alike in hardness and the more intimately interwoven the texture of the minerals, the more capable it is of receiving a good polish. Hence it follows that the very coarse crystalline granites are not so well suited for ornamental work.

The enduring properties of granites vary with the nature of the minerals in their composition. Although popularly they are regarded as our most durable building stone, there are some notable exceptions, which are evident in the natural outcrops, where this rock is found decayed to the depth of 100 to 200 feet, and in the active disintegration which is in progress in structures of the present century. Foliated varieties placed on edge in buildings, tend necessarily to scale under the great changes of temperature in our northern cities and towns.

The more rapid decomposition of the micas makes those varieties in which they occur in large flakes or aggregations more liable to decay. The condition of the feldspar also is often such as to influence the durability. When kaolinized in part, it is an element of weakness rather than of strength. The presence of the easily decomposable varieties of pyrite is not only prejudicial to strength and durability but also to the beauty of the stone as soon as it begins to decay.

The term "granite" as used among builders and architects is not restricted to rock species of this name in geologic nomenclature, but includes what are known as gneisses (foliated and bedded granites), diorites, gabbro and other crystalline rocks whose uses are the same. In fact, the similar adaptability and use have brought the latter species into the class of granites. For example, the Au Sable granite of Essex county is a norite. The term is applied in some cases to the diabases or trap-rocks, as the "granite quarries" of Staten Island.

Another massive crystalline rock which is used in building is norite, consisting of labradorite and hypersthene, with some brown mica. It is a common rock in the Adirondack region, and is known commercially as a granite.

The massive crystalline rocks are of common occurrence in New York, but not in outcrops over extensive areas, excepting in the Adirondack region and in the Highlands of the Hudson. The schistose crystalline rocks are developed extensively in the Highlands of the Hudson and on the borders of the Adirondack region. On New York island and within the city limits the gneissic rocks have been quarried at many points. In Westchester county there are belts of gneiss and mica schist, in which quarries have been opened near Hastings; near Hartsdale, east of Yonkers; at Kensico; at Tarrytown and at Ganung's, west of Croton Falls. In Putnam county there are quarries of granite near Peekskill and near Cold Spring. West of the river there are quarries on Iona island; at West Point; near Suffern's; at Ramapo; on Mount Eve, near Florida, and on Storm King mountain, near Cornwall. The outcrops of the gneissoid and granitoid rocks are so numerous in the belt of the Hudson Highlands that quarries can be opened at many points. The supply of stone is inexhaustible. On the Hudson

river, between Peekskill and Fishkill, there is a fine section of these rocks exposed.

On the borders of the Adirondack region quarries have been opened in the towns of Wilton, Hadley and Greenfield, in Saratoga county; at Whitehall, in Washington county; at Little Falls, in Herkimer county; and near Canton, in St. Lawrence county. The inaccessibility of much of this region and the distance from the large city markets have prevented the opening of more quarries in the gneissic rocks on the borders of the Adirondacks.

## Description of Granite Quarries.

**New York, Manhattan Island.**—The outcropping ledges of gneiss rocks, from Twenty-ninth street (on the west side) to the Spuyten Duyvil creek, and from about Sixteenth street northwards, on the eastern side of the island, have been cut through and graded down in so many places that a large amount of stone has been furnished, ready for laying up foundations and for common wall work. These gneisses are generally bluish-gray in color, medium fine-crystalline, highly micaceous and schistose in structure. The beds are thin and tilted at a high angle and in places are in a vertical position. The more micaceous rock is apt to flake and disintegrate on long exposure, especially when the blocks are set on edge. The more feldspathic stone of the granitic veins and dikes and the more hornblendic strata afford a better building material.

The Croton reservoir, Fifth avenue and Forty second street and St. Matthew's Lutheran church, Broome street, are constructions of the best of the island gneiss.

The gneissic rocks have been quarried extensively in the Twenty-third and Twenty-fourth wards, New York city, and in the adjacent southern towns of Westchester county.

The gray variety of gneiss has been most largely employed for the better class of building.

**New York City, Fordham.**—A micaceous gneiss is quarried on the property of St. John's College, on the corner of the Boulevard and Pelham avenue. It is of a bluish-gray shade of color, and is known locally as "bluestone." The new buildings of the college are constructed of this stone.

**Hartsdale, Westchester County.**— Gneissic rock is quarried near Hartsdale station, on the Harlem railroad, for the local market. The county buildings at White Plains are built of this stone.

Southeast of White Plains gneiss is quarried, and an example in construction is seen in the M. E. church on the main street.

**Scarsdale, Westchester County.**— The Seely quarries are a half mile west-northwest of the Scarsdale station, and near the road to Greenville. The stone obtained from this locality consists of feldspar, quartz, hornblende and a little black mica, and these minerals in parallel lines give it a foliated aspect. The exposed ledges near the quarry are firm and solid and show very little alteration due to weathering. This stone has been used in bridge work for the Bronx river aqueduct, and also in the Williams Bridge reservoir gatehouse.

**Hastings, Westchester County.**— There are three quarries in the vicinity of Hastings. One is owned and worked by the N. Y. C. & H. R. R. R. Co., one mile south of the railroad station. The Munson quarry* is three-quarters of a mile east-southeast of the village, and adjoining it on the same ridge is the Ferguson quarry.

The stone of these quarries consists of orthoclase, quartz, hornblende and biotite, arranged generally in parallel lines or thin layers, which give the rock a gray and striped appearance. The product is shipped to New York city for foundation walls, and is used for common wall work in the adjacent country.

**Yonkers, Westchester County.**— The Valentine quarry opened on the top of the hill, two miles southeast of Yonkers, and on the Mount Vernon road, is worked at long intervals. The stone is fine-grained, a mixture of reddish feldspar, quartz, and a little hornblende.

**Tarrytown, Westchester County.**— The old Beekman quarry, one and a quarter miles north of the station, and at the side of the railroad track, was worked largely in former years.

**Kensico, Westchester County.**— A gneissic rock has been quarried extensively on the east side of the Bronx river reservoir, and used in the construction of the reservoir dam.

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* Operated by Wm. G. Lefurgy.

**Union Valley, Putnam County.**— The quarries of — Jackson† and E. C. Ganung are located four miles from Croton Falls, and in the town of Carmel. The stone has a striped appearance, due to black mica and white feldspar alternating in thin layers. Its main use is for posts and foundations; some of it has been used for monuments and buildings.

**Ramapo, Rockland County.**— The quarry of Henry L. Pierson* is in the hillside near the N. Y., L. E. and W. R. R., south of the village. The stone is a quartz-syenite, consisting of orthoclase, quartz and hornblende. It is especially suited for heavy masonry on account of its strength and the large size of blocks which can be obtained. Some of this stone has been used for monumental work, and some for the Erie railway bridges.

**Sufferns, Rockland County.**— Granite for cemetery posts and monumental bases has been quarried in a small way from ledges on the roadside west of Sufferns station. It is greenish-gray in color, hard to cut and dress, but is durable.

**Peekskill, Westchester County.**— There is a granite quarry on the bank of the river two miles northwest of Peekskill.

**Iona Island, Rockland County.**— There is a large quarry on Round Island near Iona Island, owned by Daniel E. Donovan, whence stone is obtained for heavy masonry and for macadam material. A large amount is sold annually for road-making. Some of the stone used in the New York and Brooklyn bridge came from this quarry.

**West Point, Orange County.**— West of the military academy buildings a gneissoid granite has been quarried at several points for the construction of government buildings. The stone occurs in thick beds and the solid, outcropping ledges indicate the durability of the stone where exposed to the weather. The library building, the old riding academy, three of the professors residences and the long lines of retaining wall are constructed of the stone taken from these quarries.

**Garrisons.**— King's Quarry. A large quarry of fine gray granite is operated by the King Granite Company.

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* Not now in operation. † Full name not obtained.

Storm-king Mountain.—The granite quarry at the southeastern face of Storm-king mountain, near the West Shore railroad track, and a half mile south of Cornwall station, has not been in operation for several years.

Break-neck Mountain Quarry. — Granite has been quarried at several points on the southwest side of this mountain and north of Cold Spring. The quarry sites extend nearly a mile back from the river; and the work has been to detach blocks of large size by blasting and then to break them up into building stones or paving blocks as called for. The Hudson River Broken Stone and Supply Company is now working on the lands of Lewis J. Bailey, producing stone for railroad track ballast.

Mount Adam, Warwick, Orange County. — Granite was quarried at a locality, opened in 1889, on the north end of Mount Adam.

Little Falls, Herkimer County. — A hornblendic-gneiss rock, known as "blue rock," is quarried at Little Falls for the local market. It was used in the construction of the Erie canal, the N. Y. C. & H. R. R. R., in the R. C. and the Pres. churches, besides several mill and store buildings in the town. The stone has a greenish-gray color, moderately fine-crystalline texture, and is made up of orthoclase, quartz and hornblende. Some of it has a reddish tinge, due to iron stains.

Granite has been quarried in the town of Wilton, two miles north of Saratoga, in the town of Greenfield, and at Wolf Creek, in the town of Hadley. None of these quarries are worked regularly or uninterruptedly.

Adirondack Granite Company, Westport, Essex County.— The granite quarry on Splitrock mountain near the lake, and three miles from Whallonsburg, has been abandoned. Very little stone has been quarried here and little is known of it.

Ausable Granite, Essex County. — The Ausable granite is obtained from quarries on the north and west slopes of Prospect Hill, one and a half miles south of Keeseville. The principal openings are the property of the Ausable Granite Co., whose establishment for dressing the stone is located in Keeseville. This stone is moderately fine crystalline in texture and is composed

of labradorite feldspar, hypersthene and biotite. Small grains of pyrite and hematite are occasionally seen in the mass. The stone is hard and expensive to dress but it is susceptible of a high polish and is especially adapted for decorative work and for monuments. The dark, polished surface, with its chatoyant play of colors, contrasts well with the gray dressed surfaces. The glaciated ledges near the quarries show little alteration due to weathering, and are evidence of the durability of the stone. In some of the weathered surfaces the feldspars appeared changed to kaolin, and the hypersthene is badly decomposed.*

**Grindstone Island, Jefferson County.**—A red granite is quarried extensively on this island in the St. Lawrence river, northwest of Clayton. There are many outcrops, especially on the western side of the island, and small quarries have been opened at more than twenty different points.

There are three large quarries which are worked extensively and with little interruption. The granite of these quarries is rather coarse crystalline, red to bright red in color and consists of flesh colored feldspar, quartz and mica, with very little magnetite as an accessory constituent. Its resemblance to the Scotch granite has given it the name of "International Scotch granite." Examined under the microscope the feldspars show kaolinization. The durability of the stone is witnessed in the unaltered or scarcely altered rock which crops out on the two sides of the quarry. Blocks of large size can be obtained up to the limit in handling and shipping. An examination of a representative specimen of this granite shows that it has a specific gravity of 2.713, equivalent to a weight of 169 pounds per cubic foot. The absorption test indicated 1.55 per cent. of water absorbed. The loss in a dilute solution of sulphuric acid was 0.13 per cent. Freezing and thawing produced no

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* Tests of the strength of this stone made by Dr. Thos. Egleston, of Columbia College School of Mines, show that it stands 27,000 pounds and breaks at 29,000 pounds to the square inch. Dr Egleston's series of tests made for the company show further, that when heated to a bright red heat by a blast of a Bunsen burner the stone was not cracked badly; and at a temperature of 800°–1350° F. and then quenched in cold water the specimens changed in color but otherwise were hardly altered, except at the highest heat. "The outside of the piece was rendered rather crumbly and granular * * * but the piece as a whole was still hard and resists moderate blows of the hammer." [From report made to the Ausable Granite Works.]

apparent change. Exposure to a temperature of 1200 to 1400 degrees F. caused vitrifaction, destruction of color and impaired the strength so that the specimen crumbled with a blow. The greater part of the product of these quarries is in the form of paving blocks and is shipped to western cities, principally Cincinnati and Chicago. The International Granite Company of Montreal uses a large amount for monumental work and building. Examples of this granite can be seen in the large columns of the Senate Chamber of the New Capitol, Albany, and in the Nordheimer building in Montreal.

### Trap-Rocks.

Trap-rock or trap is the common name given to a class of eruptive rocks because of a structural peculiarity, and has no distinctive significance in mineralogical composition. The rocks of the Palisade mountain range and of the Torn mountain, which extends from the New Jersey line, on the west shore of the Hudson river to Haverstraw, are known as trap-rocks. There is an outcrop on Staten Island, near the north shore, where a large amount of stone has been quarried at the so-called "granite quarries."

The trap-rock of the Palisades range is a crystalline, granular mass of a plagioclase feldspar (labradorite usually) augite and magnetite. It is generally finer crystalline than the granite. The colors vary from dark gray through dark green to almost black.

This trap-rock is hard and tough, but some of it is split readily into blocks for paving. It has been used extensively in New York and adjacent cities for street paving, but since the introduction of granite blocks this use has nearly ceased. On account of its toughness it makes an admirable material for macadamizing roadways. It is so hard that only rock-face blocks are used in constructive work. Several prominent buildings in Jersey City and Hoboken are built of it. There is a large quarry on the river at Rockland lake, the output of which is for street work and road material almost exclusively. There are also quarries at Piermont and at Graniteville, Staten Island.

## SANDSTONES

Sandstones consist of grains of sand which are bound together by a cementing material.

The grains may be of varying sizes, from almost impalpable dust to small pebbles, and may be angular or more or less rounded in form. The cementing matter also may vary greatly in its nature. From this variation, both in the grains and in the cement, there is an almost endless gradation in the kinds of sandstone.

Quartz is the essential constituent, but with it there may be feldspar , mica, calcite, pyrite, glauconite, clay or other minerals, and rock fragments common to stone of sedimentary origin. These accessory materials often give character to the mass, and make a basis for a division into feldspathic, micaceous, calcareous sandstones, etc., as one or another of them predominates.

The texture of the mass also is subject to a wide range of variation, from fine-grained, almost aphanitic, to pebbly sandstone, or conglomerate, or a brecciated stone in which the component parts are more or less angular.

Some of the brown sandstones of the Triassic age, quarried near Haverstraw, are such conglomeratic and brecciated sandstones. Accordingly as the grains are small or large the stone is said to be fine-grained or coarse-grained

The variety of the cementing material also affords a basis for classification. Silicious sandstones have the grains bound together by silica. They consist almost exclusively of quartz, and grade into quartzite. The ferruginous varieties have for their cement an oxide of iron, often coating the grains and making a considerable percentage of the whole. The iron is usually present as ferric oxide. Calcareous sandstones are marked by the presence of carbonate of lime. When it exceeds the quartz in amount, the sandstone becomes a silicious limestone. In the argillaceous varieties, the binding material is a clay, or an impure kaolin.

The cementing material determines in most cases the color. The various shades of red and yellow depend upon the iron oxides ; some of the rich purple tints are said to be due to oxide of manganese.

The gray and blue tints are produced by iron in the form of ferrous silicate or carbonate. By an irregular association of

masses of different colors a variegated surface is produced, or by an alternation of white and variously-colored laminæ a striped appearance is given to the mass.

Sandstones occur stratified and in beds of greater or less thickness, and they are said to be thick-bedded or thin-bedded. In some cases the beds are so thick, and the stone of such a uniform texture, that the stone can be worked equally well in all directions, and is known as freestone. When fine-grained it is often designated as liver-rock. A laminated structure is common, and especially in the thin strata, or when the stone is micaceous. When the beds can be split into thin slabs along planes parallel to the bedding, it is called a flagstone. A less common structural character is what is termed lenticular or wedge-shaped, in which the upper and under surfaces lack parallelism, and the beds wedge out. It makes the quarrying more difficult, and produces more waste material.

These variations in the nature of the component grains, and binding material, in their arrangement, and in the forms of bedding, produce a great variety of stone, and the gradations from one to another are slight. The hardness, strength, beauty and durability are determined by these varying elements of constitution. The hardness depends upon the quartz, and the strength of the cement holding the grains or fragments together. Without the cement, or in the loosely aggregated stone, the grains are readily torn apart, and the mass falls with a blow,—a heap of sand. Generally the more silicious the stone and the cement, the greater the degree of hardness and strength. The size, color and arrangement of the component grains are the elements which affect the appearance and give beauty to the sandstone. The durability is connected intimately with the physical constitution and the chemical composition. As a rule calcareous and clayey cementing materials are not as enduring as the silicious and ferruginous. The stone best resisting the action of the atmospheric agencies is that in which the quartz grains are cemented by a silicious paste, or in which the close-grained mass approaches in texture a quartzite.

The presence of minerals liable to decomposition, as feldspar, highly kaolinized, of mica, marcasite, and pyrite, of calcite in quantity, and clays, affects the durability and tends to its destruction.

Sandstones are classified according to their geologic age also. They are found occurring in all the series, from the oldest to the most recent formations. Those of a given age are generally marked by characteristic properties, which serve for their identification, aside from the fossil organic remains by which their exact position in the geologic series is fixed. This persistence in characters is exemplified in the Medina sandstones of the State, in the Devonian bluestone of the Hudson River valley, and in those of Triassic age.

Sandstones occur in workable quantity in nearly all the greater divisions of the State.

Quarries have not, however, been opened everywhere in the sandstone formations, because of the abundant supply of superior stone from favorably situated localities. There are, in consequence, large sandstone areas and districts in which there is an absence of local development, or abandoned enterprises mark a change in conditions, which has affected injuriously the quarry industry in them.

Following the geologic order of arrangement and beginning with the Potsdam sandstone, the several sandstone formations are here briefly reviewed.

### Potsdam Sandstone.

This formation is the oldest in which, in this State, sandstone is quarried for building purposes.*

The bottom beds are a fine, silicious conglomerate; above are sandstones in thin beds generally. It is gray-white, yellow, brown and red in color. In texture it varies from a strong, compact quartzitic rock to a loosely coherent, coarse-granular mass, which crumbles at the touch.

Outcrops of limited area occur in Orange and Dutchess counties, and in the Mohawk valley. In the Champlain valley the formation is well developed at Fort Ann, Whitehall, Port Henry and Keeseville, and quarries are opened at these localities. The stone is a hard, quartzose rock, and in thin beds. North of the Adirondacks the formation stretches westward from Lake

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* Some of the sandstones east of the Hudson and in the Taghkanic range may belong to the Lower Cambrian See Amer. Jour. of Science, iii series, vol. 35, pp. 399-401. But there are no quarries opened in these localities.

Champlain to the St. Lawrence; and there are quarries in the towns of Malone, Bangor and Moira in Franklin county; in Potsdam and Hammond in St. Lawrence county; and in Clayton, Jefferson county. In parts of Clinton county the stone is too friable for building.

The most extensive openings are near Potsdam, and the stone is hard, compact and even-grained, and pink to red in color. Some of it has a laminated structure and striped appearance. It is an excellent building stone and is widely known and esteemed for its beauty and durability.

The Hammond quarries produce a gray to red stone. Nearly all of the output is cut into paving blocks and street material.

### Hudson River Group.

The rocks of this group outcrop in Orange county, northwest of the Highlands and in the valley of the Hudson river northward to the Champlain valley in Washington county. From the Hudson westward the Mohawk valley is partly occupied by them. The belt increases in breadth, thence in a northwest course across Oneida, Oswego and Lewis counties, and continues to Lake Ontario.

The rocks consist of shales and slates, sandstones and silicious conglomerates. The slates are noticed under the heading slates, and in the notes on quarry districts.

The sandstones are generally fine-grained and of light-gray or greenish-gray color. They are often argillaceous and not adapted for building purposes. But the even bedded and well-marked jointed structure makes the quarrying comparatively easy, and the nearness to lines of transportation, and to the cities of the Hudson and Mohawk valleys have stimulated the opening of quarries at many points.

For common rubble work* and for local uses the quarries in this formation have furnished a large amount of stone. The more important quarrying centers are now at Rhinecliff-on the-Hudson, New Baltimore and Troy, in the Hudson valley; at Aqueduct, Schenectady and Duanesburg, Schenectady county; and Frankfort Hill, Oneida county.

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* Prof. Amos Eaton gave the name of "rubble stone" to the sandstone in the upper part of the formation.

These quarries have a local market and do not supply much, if any, stone to distant points. Nearly all of the stone is used in foundation and common wall work.

### Oneida Conglomerate.

This formation is developed to its greatest thickness in the Shawangunk mountain in Orange and Ulster counties.

It is recognized in the Bellevale and Skunnemunk mountains, also, in Orange county. In the central part of the State it is traced westward in a narrow belt from Herkimer county into Oneida county. The prevailing rocks are gray and reddish-gray, silicious conglomerates and sandstones, which are noted for their hardness and durability. The cementing material is silicious. The jagged edges and angular blocks and the polished and grooved surfaces of the glaciated ledges, so common on the Shawangunk range, afford the best proof of the durable nature of these rocks. The bottom beds, near the slate, contain some pyrite. No attempt has been made to open quarries for stone, excepting at a few localities for occasional use in common wall work. The grit rock is quarried near Esopus Creek for mill-stones.

The accessibility of the outcrops to the New York, Lake Erie and Western railroad, the New York, Ontario and Western railroad, the West Shore railroad and the Delaware and Hudson Canal lines is an advantage, as well as the comparative nearness to New York. And no other formation in the State exhibits in its outcrops better evidence of ability to resist weathering agents·

### Medina Sandstone.

The Medina sandstone is next above the Oneida conglomerate. It is recognized in the red and gray sandstones and the red and mottled (red and green) shales of the Shawangunk and Skunnemunk mountains in Orange county. A large amount of the red sandstone has been quarried on the north end of the Skunnemunk range, in the town of Cornwall, for bridge work on the railroads which cross the range near the quarry.

The red sandstone is seen exposed in the cuts of the Erie railway northeast of Port Jervis. This formation reappears in

Oswego county, and thence west to the Niagara river in a belt bordering Lake Ontario.

Prof. Hall describes it as follows: "The mass is usually a red or slightly variegated sandstone, solid and coherent in the eastern extremity of the district, becoming friable and marly in the western extension, and admitting an intercalated mass of gray quartzose sandstone, which contains marine shells; while in the red portions are rarely found other than marine vegetables or fucoids."*

Quartz is the principal mineral constituent associated with some kaolinized feldspar. The cementing material is mainly oxide of iron, with less carbonate of lime. The stone is even-bedded and the strata dip gently southward The prevailing systems of vertical joints, generally at right angles to one another, divide the beds into blocks, facilitating the labor of quarrying.

Quarries have been opened at Fulton, Granby and Oswego, in Oswego county; at several points in Wayne county; at Rochester, on the Irondequoit Creek, and at Brockport, Monroe county; at Holley, Hulburton, Hindsburg, Albion, Medina and Shelby Basin, in Orleans county; and at Lockport and Lewiston, in Niagara county. The Medina sandstone district proper is restricted to the group of quarries from Brockport west to Lockport.

The leading varieties of stone are known as the Medina red stone, the white or gray Medina and the variegated (red and white) or spotted. The quarries in this district are worked on an extensive scale, and their equipment is adequate to a large annual production. The aggregate output is larger and more valuable in dimension stone for dressing than that of any other quarry district in the State. Including the stone for street work, the total value is greater than that obtained from the stone of any other geological formation in the State. The stone has gained a well-deserved reputation for its value as a beautiful and durable building material; and its more general employment, both in construction and in paving, is much to be desired. The extent of the outcrops offers additional sites for quarrying operations, and the greater use of this stone, and the increase of the producing capacity of the district are here suggested.

* Survey of the Fourth Geological District, James Hall, Albany, 1843, p. 34.

### Clinton Group.

The rocks of this group are shales, thin beds of limestone and shaly sandstones. They crop out in a narrow belt from Herkimer county west to the Niagara river and bordering the Medina sandstone on the south. Sandstone for building has been quarried in the southern part of Herkimer county; at Clinton, near Vernon and at Higginsville in Oneida county, from this formation. The nearness of the Medina sandstone, with its more accessible quarries and superior stone, has prevented the more extensive development of the quarrying industry in the sandstone of the Clinton group.

### Oriskany Sandstone.

The Oriskany sandstone formation is best developed in Oneida and Otsego counties. The rock is hard, silicious and cherty in places, and generally too friable to make a good building stone. No quarry of more than a local importance is known in it.

### Cauda Galli Grit and Schoharie Grit.

These rocks are limited to Schoharie and Albany counties and to a very narrow belt which stretches south and thence southwest to Ulster county. The Cauda Galli sandstones are argillaceous and calcareous and are not durable. They are used in Albany county for roadmetal. The Schoharie Grit is generally a fine-grained, calcareous sand-rock which also is unsuited for building. Quarries in these rocks have local use only.

### Marcellus Shale.

As its name implies, this formation is characterized by shaly rocks, which are not adapted to building. The abundance of good building stone in the next geologic member below it — the Corniferous limestone — whose outcrop borders it on the north throughout the central and western parts of the State, also prevents any use which might be made of its stone. A single quarry was at one time opened in it at Chapinville, Ontario county

### Hamilton Group.

The rocks of the Hamilton group outcrop in a narrow belt. which runs from the Delaware river, in a northeast course, across

Sullivan and Ulster counties to the Hudson valley near Kingston; thence north, in the foot-hills, bordering the Catskills, to Albany county; then, bending to the northwest and west across the Helderberg mountains into Schoharie county; thence, increasing in width, through Otsego, Madison and Onondaga counties, forming the upper part of the Susquehanna and Chenango waters; thence west, across Cayuga, Seneca, Ontario, Livingston, Genesee and Erie counties to Lake Erie. In this distance there is some variation in composition and texture. In the western and central parts of the State there is an immense development of shales and the few quarries in the sandstones referable to this group are unimportant.* In the Helderbergs, in the Hudson valley and thence, southwest, to the Delaware river, the sandstones predominate, and all of the beds are more sandy than at the west. There is a great development of the bluish-gray, hard, compact and even-bedded sandstone, which is known as "Hudson river bluestone," and is used so extensively as flagging. Some of the thicker beds yield stone for building also. The sandstone occurs interbedded irregularly with shales at most localities. The bluestone or flagstone beds are generally in the upper part of the Hamilton and they continue upward into the horizon of the Oneonta sandstone. The number of quarries in this blue-stone district, in Sullivan, Ulster, Greene, Albany and Schoharie counties, is large and can be increased indefinitely, as nearly the whole area of the formation appears to be capable of producing stone for flagging or for building. The difficulty of indicating the division line between the Hamilton and the Oneonta and the Hamilton and the Portage group of rocks makes it impossible to refer to localities more particularly. The quarries near Cooperstown, in the lake region, particularly at Atwater, Trumansburg, Watkins' Glen and Penn Yan belong to the Hamilton group.

### Portage Group.

In this is included the Oneonta sandstone, the limits of which at the east can not be indicated and the flagstone beds of the Hudson valley and of the eastern part of the State continue up

* Geology of New York. Survey of the Fourth Geological District, by James Hall, Albany 1843, pp. 184-5.

into the Oneonta sandstone horizon. Many of the quarries are in the latter formation. The more western and northwestern and higher quarries are in it; and some of the Chenango county quarries also.

The Portage rocks in the western part of the State consist of shales at the base; then shales and flagstones; and the Portage sandstone at the top. In the last division thick beds with little shale are marks of this horizon. The stone is generally fine-grained. The quarries near Portage and near Warsaw are in it; also the quarries at Laona and Westfield in Chautauqua county.

Although not of as great extent in its outcrop as the Hamilton group the Portage rocks are developed to a thickness of several hundred feet along the Genesee river at Mount Morris and at Portage; and form a belt having a breadth of several miles through Tompkins, Schuyler, Yates, Ontario and Livingston counties, and thence west to Lake Erie.* The formation is capable of supplying an immense amount of good building stone and flagstone throughout its undeveloped territory.

### Chemung Group.

The rocks of the Chemung group crop out in the southern tier of counties, from Lake Erie eastward to the Susquehanna. The shales are in excess of the sandstones in many outcrops, and there is less good building stone than in the Portage horizon. The variation in color and texture is necessarily great in the extensive area occupied by the Chemung rocks, but the sandstones can be described as thin-bedded, generally intercalated with shaly strata, and of a light-gray color, often with a tinge of green or olive-colored. The outcropping ledges weather to a brownish color.† Owing to the shaly nature of much of the sandstone of the Chemung group, the selection of stone demands care, and the location of quarries where good stone may be found is attended with the outlay of time and money, and with great chances of possible failure. Quarries have been opened near the towns and where there is a market for ordinary grades of common wall stone, and also for cut stone, but the larger part of their product

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* Report of Prof. Hall above cited, pp 238-9.

† Prof. Hall's Report on Fourth District (cited above), pp. 251, 252.

is put into retaining walls. At Elmira and Corning good stone has been obtained, which is expensive to dress, and does not compete for fine work with sandstones from districts outside of the State. The quarries at Waverly, Owego, Elmira and Corning, and nearly all of the quarries in Allegany, Cattaraugus and Chautauqua counties are in the Chemung sandstone.

### Catskill Group.

As implied in the name, this formation is developed in the Catskill mountain plateau in the eastern part of the State. Sandstones and silicious conglomerates predominate over the shales. The thicker beds of sandstones are generally marked by oblique lamination and cross-bedding, which make it difficult and expensive to work into dimension blocks. Except for flagging and for local use but little is quarried. There are no large towns in the district, and consequently the demand is light. There are, however, some good quarries, which are worked for flagging, chiefly along the New York, Ontario and Western railroad and the Ulster and Delaware railroad lines in Ulster and Delaware counties; and in the Catskills, in Greene county, there are quarries in Lexington, Jewett, Windham, Hunter and Prattsville.

### Triassic Formation.

This formation, which is known as New Red Sandstone, or locally, as the red sandstone, is limited to a triangular area in Rockland county, between Stony Point on the Hudson and the New Jersey line, and to a small outcrop on the north shore of Staten Island.

The sandstones are both shaly and silicious, and the varieties grade into one another. Conglomerates of variegated shades of color also occur, interbedded with the shales and sandstones. Formerly these conglomerates were in favor for the construction of furnace hearths. They are not now quarried. The prevailing color of the sandstone is dark-red to brown, whence the name "brownstone." In texture there is a wide variation, from fine conglomerates, in which the rounded grains are somewhat loosely aggregated, to the fine, shaly rock and the "liver rock" of the quarrymen. Oxide of iron and some carbonate of lime are the cementing materials in these sandstones.

'The well-known Massachusetts Longmeadow sandstone and the Connecticut brownstone are obtained from quarries in the Connecticut valley region, and of the same geological horizon. The Little Falls, Belleville and Newark freestones are from the same formation in its southwest extension into New Jersey.

Quarries were opened in this sandstone more than a century ago, and many of the old houses of Rockland county are built of this stone. Prof. Mather reported thirty-one quarries on the bank of the Hudson near Nyack. The principal market was New York city, and the stone was sold for flagging, house trimmings and common walls. The Nyack quarries have been abandoned, with one or two exceptions, as the ground has become valuable for villa sites and town lots. There are small quarries at Suffern, near Congers Station, near New City, and west of Haverstraw, at the foot of the Torn mountain. They are worked irregularly and for local supplies of stone. The stone is sometimes known as "Nyack stone," also as "Haverstraw stone."

## DESCRIPTION OF SANDSTONE QUARRIES

### Potsdam Group.

Fort Ann, Washington County.— A gray sandstone is quar ried two miles north of the village, and at the side of the canal. It is used in Whitehall.

Whitehall, Washington County.—The cliffs of Potsdam sandstone, east of the town, yield stone for local use. The stone is hard and strong, and is valuable for foundations, retaining walls, and where it can be used without much cutting or dressing.

Port Henry, Essex County.—The outcrops of the Potsdam sandstone in the town and west of it afford quarrying sites. The quarry of L. W. Bond is worked for the local market, and the towns on the line of Delaware and Hudson Canal Company's railroad in the Champlain valley. The stone is hard, of a gray shade, excepting the surface beds, which are weathered to a rusty-red color. It is nearly all silica, and is capable of resisting the ordinary atmospheric agents for years, when the blocks are laid on their bedding planes A serious drawback to its more extensive use is the cost of cutting and dressing.

Examples of this stone in construction are seen in the Presbyterian church, and in the Sherman Library building, and the railroad depot in the town.*

Keeseville.— The Ausable river, the boundary line of Essex and Clinton counties, has at this place, and at the famous chasm below the village, worn its bed down deeply into the sandstone, and along its bank quarries have been opened in both counties for local supply.

The thin beds make a fairly good flagging-stone. The heavier beds yield good stone for ordinary wall work; and a great amount of it has been put into buildings in Keeseville. In color it is gray-white. It is rather more granular and not as hard as the Port Henry sandstone.

Malone, Franklin County.— The sandstone of the Potsdam horizon is opened by small quarries at this point, and at localities to the west, but they are unimportant, and the next group to be noted is at

Potsdam, St. Lawrence County.— The formation is so well developed in the valley of the Raquette river, southeast of the village of Potsdam, that it has been named the Potsdam sandstone.

Thomas S. Clarkson's estate† and Mrs. Charles Cox, the latter operating under the name of the Potsdam Red Sandstone Company, have quarries along the river, at an average distance of three miles, east-southeast of the village. The beds range in thickness from a few inches to six feet, and afford blocks of varying sizes. In most of the beds there is a more or less laminated structure, especially in the darker-red colored stone.

The color is light-pink, light-red or salmon colored, and red to reddish brown, varying in the several openings.

A representative specimen, taken from the company's quarry, has a specific gravity of 2.604, equivalent to a weight of 162 pounds to the cubic foot. Its percentage of silica is relatively large, and the cementing material appears to be silicious also. The oxide of iron, as determined by analysis, is 0.36 (ferrous oxide) in amount.

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* This quarry yielded the trails of trilobites upon ripple-marked beds, fine specimens of which are in the State Museum, and the American Museum, New York. (See Forty-second Annual Report, New York State Museum, pp. 25-29.)

† A. Clarkson, Secy.

In the absorption test 2.08 per cent. of water was absorbed by the dry stone. There was no loss of weight in repeated treatment with water containing carbonic acid gas and with sulphurous acid gas. A solution of 1 per cent. of sulphuric acid occasioned a slight loss in weight, equivalent to 0.02 per cent. The test of freezing and thawing left the stone apparently unchanged. When heated to 1,200 ° –1,400 ° F. and suddenly cooled, the color was unaltered, there were no checks, and the strength of the specimen was but little impaired.

Potsdam sandstone has been tested severely in its home. The wide range of temperature between the maxima of summer and the minima of winter, and the large annual precipitation, of which a considerable part is in the form of snow, present the conditions which demand material with resisting capacity. The houses of General Merritt and Senator Erwin, and other buildings, erected about sixty years ago, are solid structures to-day. The arris and corners are as sharp as when first cut, and the faces show no sign of scaling or flaking. The pavements also show how well the stone wears under use, not becoming smooth and slippery when wet. The Normal school buildings, the town hall, the Cox block, and the Presbyterian, Universalist and Episcopal churches are the more prominent structures of this stone in Potsdam. In the last-named church there is much carved work, making it very expensive on account of the hardness of the stone.

The Potsdam stone finds a wide market, and the demand for it is growing, as its beauty, strength and durability are better known and appreciated.

On account of its hardness, and the cost of fine-tool dressing, the stone is best adapted to rock-face, ashlar work. It may be seen in the "Florence," South Salina street, Syracuse; All Saints' Cathedral, Albany; Columbia College and Rutger's Protestant Episcopal Church, Seventy-second street, New York city; Reid building, Seventh avenue and Sterling street, Brooklyn; the State Asylum, at Matteawan; the New York State Asylum and City Opera House, Ogdensburg; and in the Dominion Parliament buildings at Ottawa, Canada.

Hammond, St. Lawrence County.— Sandstone is quarried at three localities in the town of Hammond, and on the line of the Rome, Watertown and Ogdensburg railroad. The stone lies in beds

which dip about 5° eastward and, owing to the well-defined joints and the evenness of the bedding, blocks are worked out readily which are suitable for cutting into curbing and flagging stone, or for making paving blocks. Its color is gray-white — in places striped, red and white. It is hard, and is nearly all silica. Unlike the quarries at Potsdam there is little earth covering, and the beds worked are not deep.

The output of the Hammond quarries is nearly all consumed in street work, and goes to Utica, Syracuse, Rome, Binghamton, Ogdensburg and to western cities.

Clayton, Jefferson County.— The Potsdam sandstone formation crops out at Clayton, and affords a hard and durable stone for local demands.

### Hudson River Group.

Highland, Ulster County.— Quarries on the river bank, two miles north of Highland station, were formerly worked extensively.

Rhinebeck, Dutchess County.— The New York Central and Hudson River Railroad Company continues work at its quarry, a half mile south of the station.

New Baltimore, Greene County.— The sandstone is here on edge, and is generally in thick beds, interstratified with a black, shaly rock. The quarries are not worked to the same extent as in former years. The stone is dark-gray to slate colored. Much stone has been obtained here for the Hudson river dyking and for dock-filling.

Troy, Rensselaer County.— Sandstone is quarried on Pawling avenue, near the Memorial Church, and on Fourth street, near and south of the Poestenkill. It is used for foundations and common wall work in the city, exclusively. The quarries are in operation at such times as the demand for stone requires.

Aqueduct, Schenectady County.— Three quarries have been opened at this point. The stone is gray to blue in color and fine-grained. It is known in the market as "Schenectady bluestone," and is used in common wall work in Albany, Cohoes and Troy.

Stone with natural-face (joint) surfaces and even-bedded is broken into rectangular blocks and is used in ashlar work. Some

of the older stone buildings in Albany have their walls of these natural-face blocks.

**Schenectady.**—Albert Shear & Co. have a quarry on the canal, one mile east of the railroad depot, which is the source of supply to a large extent, for stone used in the city, although shipments are made to Albany, Waterford, Cohoes, Troy, Mechanicville and Saratoga.

This stone can be seen in the Memorial Hall of Union University and in the East Avenue Presbyterian Church; in the new armory, Albany; in the church at Menands Station, and in St. Patrick's Roman Catholic Church in West Troy. The stone has a bluish shade of color and is fine-grained.

**Duanesburg, Schenectady County.**—A quarry in a bluish-colored sandstone, probably of the same geological horizon as that of the Schenectady quarry, is here worked by Albert Shear & Co. The stone is rather coarse-grained but is stronger than the Schenectady bluestone.

The shaly nature of much of the Hudson river group of rocks in the Mohawk valley, west of Schenectady, and the accessibility of good limestone for building purposes, has prevented the opening of quarries in it. Further west, and near Rome, there are small quarries which are referred to this horizon, but they are unimportant. The stone is generally gray in color, fine-grained and hard, and in moderately thick beds. None of these quarries do much more than a small local business; and they are not in operation all of the working season of the year.

Good building stone of the Hudson river horizon is said to have been obtained at quarries southeast of **Rome**; also at **Woodruff's, Oneida County**[*].

## Clinton Group.

This formation furnishes a building stone in Herkimer and Oneida counties, and quarries are opened in the towns of Frankfort, New Hartford, Kirkland and Verona. The city of Utica uses the greater part of the stone from the quarries at **Clinton**

* Survey of the Third Geological District, Lardner Vanuxem, Albany, 1842, p. 261.

and those on Frankfort Hill. The stone of the latter place is dark-gray and red-brown in color, medium fine-grained and hard, so that dressing is costly. It is used for foundations and common wall work, mainly. Grace Protestant Episcopal Church, on Genesee street, and the Lutheran Church, on Columbia street, are built of this stone.

Sandstone has been extensively quarried at Higginsville, Oneida County, by a Utica company. It is dark-gray and olive-green in color; hard, and dressed with difficulty. Some of this stone has been used in Rome. Fine examples of it are the Baker and Gilbert houses, on Genesee street, Utica.

## Medina Group.

Oswego, Oswego County.— Quarries for the supply of stone for foundation and retaining walls in the city are opened on the lake shore, east of the Fort Ontario grounds.

Oswego Falls, Oswego County.— The river cuts through the sandstone here and offers facilities for small quarry operations in the bluffs on the left bank. A dark-red sandstone is obtained under earth and shaly rock. The First Presbyterian Church in Syracuse is an example of badly selected stone and set on edge in many cases. A great deal of it has been used in Fulton, Oswego and Syracuse.

A specimen from the quarry of Hughes Brothers of Syracuse was found to have a specific gravity of 2.62, and an equivalent weight of 163.5 pounds to the cubic foot. It contained 0.59 per cent of ferrous oxide, and 1.71 per cent. of ferric oxide. The absorption test gave as a result 3.53 per cent. It lost weight in the treatment with acid solutions. In the freezing and thawing it checked badly, and at a high heat its color became brick-red, and its strength was impaired.

Granby, Oswego County.— The Granby Brownstone Company, O. J. Jennings, manager, works the quarry on the line of the Delaware, Lackawanna and Western railroad, two miles south of Fulton. The stone is fine-grained, purplish-red in color, and admits of fine-tool dressing. It has been used in the following structures in neighboring towns and cities: Second National

Bank building, Oswego; Protestant Episcopal church, and a block of stores in Cortland; and new Jewish synagogue, Buffalo.

Small quarries are opened westward in this formation at

Camden, Oneida County
Sterling, Cayuga County
Wolcott, Wayne County
Penfield, Monroe County

At **Rochester** the gorge of the Genesee river exposes to view a fine section of the formation. Formerly some stone was obtained from quarries in the river bluffs. In Monroe county generally this sandstone is *too argillaceous to be durable.**

What is more particularly known as the Medina sandstone district, is that portion of the outcrop which extends from Brockport in Monroe county west to Lockport. The belt is narrow, and the quarries are opened in it near the Erie canal. They are grouped here as follows:

Brockport, Monroe County
Holley, Orleans County
Hulberton, Orleans County
Hindsburg, Orleans County
Albion, Orleans County
Medina, Orleans County
Shelby Basin, Orleans County
Lockport, Niagara County

**Brockport.**— Two quarries are opened at this place.

**Holley, Orleans County.**— There are five quarries at Holley. Those of Downs & Bowman, Michael Slack, and O'Brien & Co., Fletcher & Sons,† and the Big Six Stone Company are near the canal and the New York Central railroad. The beds lie nearly horizontal, and under a light stripping of earth and boulders. The stone is of a light-red color and fine-grained.

The output is largely in the form of blocks for street paving, curbing, crosswalks and gutter stone.

Rochester, Buffalo, Syracuse, and western cities, as far as Kansas City, are markets.

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* Prof. Hall's Report on the Survey of the Fourth District, Albany, 1843, pp. 422-3.
† Not at present in operation.

**Hulburton, Orleans County.**— This group of quarries is west of the village, on the north side of the canal, stretching along a distance of two and a half miles.* They are all worked to a depth below the canal water-level, and pumping is necessary to drain them. The stripping of drift-earth does not exceed ten feet. Some of the beds are thick, and blocks of large size are obtained. The stone is mostly fine-grained, and light to dark-red in color. The best quality is shipped for building stone. The greater part of the product is split into paving blocks and crosswalks and curbstone, which are shipped to Rochester, Buffalo and western cities.

Much of the Hulburton stone is sold under the name of Medina block. Examples in construction are the Delaware Avenue Methodist Episcopal Church, Buffalo, and Sibley College, Cornell University, Ithaca.

**Albion, Orleans County.**— The largest quarries of Medina sandstone are at Albion. They are east of the town, between the canal and the New York Central railroad. The parties here at work are: Goodrich and Clark Stone Company, Albion Stone Company, and Gilbert Brady, of Rochester. The stripping on the sandstone is from three to fifteen feet thick. The beds dip a few degrees to the south, and are of varying thickness, from a few inches up to six feet. Regular systems of joints facilitate greatly quarrying operations. There is considerable variation in the nature of the stone in the several beds, and even in the same bed, as followed in the same quarry. Generally it is of a light-red color, and fine-grained.

A specimen representing the best building stone, as quarried by Mr. Brady, has a specific gravity of 2.598, and a weight (calculated) per cubic foot of 162 pounds. The percentage of oxide of iron is comparatively low, being 0.51 and 0.09 for ferrous oxide and ferric oxide, respectively. The absorption test gave 2.37 per cent. The losses in weight, in the tests with carbonic acid gas and sulphurous acid gas, were 0.09 and 0.29 per cent. The treatment with sulphuric acid, 1 per cent. solution, occasioned a loss of 0.08. The alternate freezing and thawing pro-

* Sturaker & Sullivan, Thomas Lardner, R. O'Reilly, A. J. Squire, L. Cornwell, C Von York, C. F. Gwynne, M. Scanlon, Hebner Brothers, George Hebner, E. Fairhen and A. H Ford have quarries here.

duced no visible effect. After a subjection to a high temperature and sudden cooling, the strength was but little impaired and the color was slightly changed.

These quarries employ from one hundred and fifty to two hundred men each, and the aggregate product, annually, amounts to many thousands of tons. The bulk of the stone quarried by the Albion Stone Company, and the Goodrich and Clark Stone Company, is used for street purposes, as paving, curbing, gutters and crosswalks. Platforms of large size, and smooth and true surfaces, are cut from some of the thick beds.

The paving blocks are sold principally to western cities — Erie, Akron, Cleveland, Toledo, Columbus, Detroit, Chicago and Milwaukee. The Brady quarry produces stone for building, principally.

These quarries are conveniently located for working, at the side of canal and railroad, and are well equipped for a large business.

Some examples of the Albion stone are the Presbyterian church, Albion; the Iroquois Hotel, Young Men's Association building and Trinity Protestant Episcopal Church in Buffalo; Guernsey building, No. 160 Broadway, New York city; steps of the new staircase, Capitol in Albany.

**Medina, Orleans County.**— Medina has given name to this sandstone formation because of its development and the characteristic fossils which are abundant in some of the gray beds at this locality. Within a mile and a half of the railroad station there are, north and northeast of the town, the quarries of Kearney & Barrett, A. M. Holloway, Sara J. Horan, Buffalo Paving Company, Noble & Lyle and C. A. Gorman. The working season is naturally from the first of April to the middle of November. The rest of the year is given to stripping off the overlying earth and waste rock. As compared with the stone of the quarries in the Medina sandstone formation, eastward, the color is lighter gray, and there is the variegated, or spotted red and white, and a light red. Generally it is harder. Oblique lamination in the beds is more common than at Albion or Hulberton. Pyrite-coated seams and joint faces are seen, chiefly in

the older quarries now idle. Formerly the light-colored gray stone was in demand, and was quarried for building; now nearly all of the gray variety is split into paving blocks, and the fashion for building calls for the red and the variegated stones. At the extreme northeast the Noble & Lyle quarry produces a reddish-brown stone which is more like the Hulberton stone, and is rather softer than that of the quarries to the west and southwest. It is used for building almost exclusively. In this quarry, and in some of the others, a red, shaly rock, known here as "red horse," is found under the quarry beds which is waste. The dip is south at a small angle; a regular system of vertical joints runs an east west course, with a north-south system, less well defined. The total thickness of quarry beds is in places as much as thirty feet, and the range is from two inches to six feet. The larger part of the aggregate production of these quarries is put into street material. The chief markets are Syracuse, Rochester, Buffalo, Erie, Cleveland, Columbus, Toledo, Detroit, Milwaukee and as far west as Omaha and Kansas City.

Lockport.— Quarries in the Medina sandstone formation were opened near the town, to the north, as early as 1824, and much of the stone was used in buildings, which are good examples of its durability. The quarries are on the right bank of the Eighteen Mile creek, and are connected with the New York Central railroad by a branch road one mile in length. Stone for flagging, paving blocks, and for building is obtained. Gray, red and mottled varieties occur in these openings. Formerly these quarries furnished stone to outside buyers; at present, they are worked almost exclusively for local market

Lewiston, Niagara County.— The same formation has afforded some building stone and some flagstone at this location.

## Hamilton and Portage Groups.

### *Hudson River Bluestone.*

The term "Hudson River Bluestone" is used to designate the blue, fine-grained, compact and even-blended sandstone, which is so largely employed for flagging and house trimmings in New York city, and to some extent in all of our middle Atlantic coast

cities and towns. "The belt of country in which it is quarried is nearly one hundred miles long in New York, stretching from the southwestern towns of Albany county, across Greene and Ulster and the western part of Orange and eastern part of Sullivan counties to the Delaware river. In Albany and Greene counties it is narrow, as also in Saugerties in Ulster county, making the foot hills, as it were, on the east and east southeast of the Catskill mountains, and bounded on the east by the older limestone formations. It widens in the towns of Kingston, Woodstock, Hurley, Olive and Marbletown, and in them the quarries are distributed over the 500-foot plateau which borders the mountains on the southeast. To the northwest, and in the valley of the Esopus creek, many localities near the line of the Ulster and Delaware railroad have been opened and worked. They are a part of the bluestone district geographically, although the geological formations are not the equivalent of the main belt at the southeast. There are scattering localities in the towns of Rochester and Wawarsing and thence southwest, in Sullivan county, which furnish bluestone for local markets, and for exportation where they are situated near enough to lines of shipping."

The belt, as above described, has in it outcrops of shales and sandstones, belonging to the several geological formations, from the Hamilton period to and including the Catskill, in short, rocks of the Upper Devonian age. There are quarries along the Hudson river at New Baltimore, and thence southward, at Coxsackie and Catskill and near Rondout, but they are not in the typical bluestone, but in sandstone of the Hudson River group. The quarries of Palenville and vicinity, of West Saugerties, High Woods, Boiceville, Phœnicia, Woodland Hollow, Shandaken, and Pine Hill are above the horizon of the Hamilton formation and probably all in the Catskill group of rocks. The Oneonta sandstone, which is the equivalent of the Portage group, may form a part of the belt near the foot of the mountains, but it is impossible to define its limits and to designate the quarries in it. The quarries at Roxbury and Margaretville and their vicinity are in the Catskill formation. The openings along the Port Jervis, Monticello and New York railroad, in Sullivan county, are probably in the same horizon. The main bluestone

belt, where it has been so extensively opened, as in the towns of Saugerties, Kingston and Hurley, is of the Hamilton period.

"Beginning at the northeast, there are small quarries at Reidsville and Dormansville, seven miles west of the Hudson river, and in Albany connty. They have furnished a great deal of stone for flagging in the city of Albany. The stone of these quarries is gray in color and rather coarser-grained than the typical bluestone of the Hudson river quarries.

"In Greene county there are several small quarries near Leeds, which are worked mainly for the Catskill market. In the vicinity of Cairo stone is quarried at several places, and shipped by rail. On the line of the Stony Clove and Catskill Mountain railroad, and along the Kaaterskill railroad, quarries have been opened, from the mountain houses southwest to Phœnicia."

Ulster county is the largest producer of bluestone, and its quarry districts are the following: Quarryville, West Saugerties and High Woods, in the town of Saugerties; Dutch Settlement, Hallihan Hill, Jockey Hill, Dutch Hill and Stony Hollow, in the town of Kingston; Bristol Hill, Morgan Hill, Steenykill and West Hurley, in the town of Hurley; Marbletown, Woodstock, Brodhead's Bridge, Shokan, Boiceville, Olive, Phœnicia, Woodland Hollow, Fox Hollow, Shandaken, Pine Hill and Rochester and Wawarsing quarries, in the valley of Rondout creek and its tributaries.

There is much variation in the several quarries of these localities both in the nature and thickness of the overlying earth or stripping, and in the number and thickness of the workable quarry beds. A large number of quarries have been opened, and at many places the valuable stone has been removed and the quarries abandoned. At other localities the thickness of the overlying earth and the long distance from transportation lines have prevented their further development. The tendency of later years has been to open quarries nearer the lines of railroad, and to leave localities more distant, so that the number of quarries in the territory adjacent to the Ulster and Delaware road has been greatly increased. The aggregate output of this part of the territory has not materially increased within the last few years, in consequence of the abandonment of many quarries and the re-

strictions placed upon the quarry industry by the business relations to which it is subject.

The quarry beds range from an inch to three feet and, in some instances, up to six feet in thickness. The top beds are generally thin. In most cases these thick strata can be split along planes parallel to the bedding and the cap-layer is raised by means of wedges. The size of blocks obtained is determined by the natural joints which divide the stone vertically. Stones sixty feet by twenty feet have thus been lifted from a bed. The facilities for handling and lifting really limit the size. The thicker stone are cut into curbing, crosswalk and sidewalk stones and large platforms, yielding what is known as flagstone. The thinner beds furnish flagging for towns and villages. A part of the thinner stone is cut into dimension work for water-tables, sills, lintels, posts and window-caps or house trimmings in general.

"The stone obtained in these several districts varies in color, hardness and texture and consequently in value, from quarry to quarry, and even in the same quarry. In nearly all of the localities the beds vary a little from top downward; rarely is there much variation horizontally, or in the same bed. Hence, any given bed may be said to have a certain character; that is, produces a given grade of stone. The color is predominantly dark-gray or bluish-gray, and hence (more by contrast with the red sandstones) a "bluestone" Reddish-brown and some greenish gray stones occur in the quarries higher in the mountain sides, as in the valley of the Esopus creek above Shokan and in the Palenville quarries. There is a decided preference for the typical "bluestone" over the reddish or brownish-colored grades. In texture the range is from the fine shaly or argillaceous to the highly silicious and even conglomeratic rock. The best bluestone is rather fine-grained and not very plainly laminated, and its mass is nearly all silica or quartz, which is cemented together by a silicious paste and contains very little argillaceous matter. Hence, the stone is hard and durable and has great strength or capacity of resistance to crushing or compression. Coarse-grained sandstones and even fine conglomerates occur and are quarried in some localities. These sandstones are not often found loosely cemented together and friable; and they are rarely open and porous."

A representative specimen of the best Hudson river bluestone, and obtained from the Bigelow Bluestone Company* of Malden, was subjected to a series of tests, with the following result: specific gravity, 2.751; weight per cubic foot, 171 pounds; ferrous oxide, 4.63 per cent.; ferric oxide, 0.79 per cent.; water absorbed, .82; loss in dilute sulphuric acid solution, .20 per cent.; alternate freezing and thawing, unchanged; at temperature of 1200°–1400° Fahr. color changed to dull red, slightly checked and strength somewhat impaired.

"The bluestone territory southwest of Ulster county is confined to a narrow belt crossing the towns of Mamakating, Thompson, Forestburg and Lumberland in Sullivan county and Deerpark in Orange county. There are quarries near Westbrookville, near Wurtsboro, along the Port Jervis, Monticello and New York railroad and on the Delaware river at Pond-Eddy and Barryville."

Flagstone is obtained along the lines of the New York, Ontario and Western railroad, and of the Ulster and Delaware railroad at Westfield Flats, Trout Brook, East Branch, Margaretville, Roxbury and Grand Gorge. All of these quarries are in the Catskill group of rocks, and the stone from them is more generally a reddish or brown-tinted sandstone.

It is more open-grained and not so dense and strong as the best Ulster county stone. It reaches the market with the product of the Ulster county quarry and is included in the bluestone production. The principal shipping points whence bluestone comes to the market are Malden, Saugerties, Kingston (including Wilbur and Rondout). A great deal of stone is cut for house trimmings, in mills in Malden, Brodhead's Bridge, West Hurley, Wilbur, Kingston and Rondout, but the larger number of feet is sent into market simply quarry-dressed, for flagging and curbing. Its superiority as a flagging-stone is recognized generally by residents of New York city and adjacent towns where it has been so extensively used.

"It is so compact as not to absorb moisture to any extent, and hence soon dries after rain or ice; it has the hardness to resist abrasion and wears well; it is even-bedded, and thus presents a good and smooth natural surface; and it has a grain which pre-

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* Now the Ulster Bluestone Co.

vents it becoming smooth and slippery as some of our granites, our slates and our limestones, when so used in walks. It is strong, and is not apt to get broken. But owing to the many thin beds and the use of too thin stones, sidewalks often become unsightly and bad because of breaks, a fault common to all flagstone when laid in such thin beds or blocks.

"For use in houses and business buildings Hudson river bluestone is having an increasing market. It is admirably adapted for lintels, window-caps, sills, doorsteps, water-tables, etc., with brick, both because of its strength and its durability. None of our sandstones from other districts, and not even our best granites are as strong to resist transverse pressure or strain. Tests (comparative) show that it is fully three times as strong, in this way of resistance, as granite, marble, Ohio sandstone and Connecticut and New Jersey brownstones. To resist compression it is not much superior to these sandstones, and not equal to the best granites. Its strength against transverse strains fits it for lintels, sills, caps and water-tables especially."

**Oxford, Chenango County.**—The F. G. Clarke Bluestone Company, successor of F. G. Clarke & Son, has the large quarry on the northwest of the village, and in the hillside west of the Chenango river.

The strata are horizontal and thin at the top; below the thick-bedded "liver rock" is found, from which blocks of large size are cut. The stone is blue, fine-grained and homogeneous in texture. Its specific gravity is 2.71¹, and its weight per cubic foot is 168.9 pounds. The absorbed water was found to be 1.11 per cent. It was not materially affected by the freezing and thawing tests. At a high temperature, 1,200°–1,400° F., the color was changed to dull red, and the stone was checked badly.

A partial analysis showed the presence of 3.46 per cent. and 0.16 per cent. of ferrous acid and ferric acid respectively. A crushing test of the strength of this stone, made in 1884, showed a resistance of 13,472 pounds to the square inch.

Architects and builders object to this stone in common with other bluestone, for work in which there is much carving and fine tooling, on account of its hardness and the greater expense

involved in working it, as compared with softer sandstones and limestones.

The plant includes a planer, rubbing-bed and three gangs of saws, driven by steam power, besides quarrying machinery proper.

The principal use is for house trimmings and large platforms and steps. During the quarrying season one hundred and fifty men are employed, and in 1889 one thousand four hundred carloads of stone were shipped. The market is in the cities of the eastern States.

The lower portion of Aldrich court, 41–43 Broadway, the steps, residence of Cyrus Clark, Riverside avenue and Ninetieth street, New York; steps in the terrace approaching the Capitol, Washington, District of Columbia; steps, platforms and column bases of Capitol, Trenton, New Jersey; St. Lawrence Hall, New Haven, Connecticut; part of State Prison for Insane Criminals, Matteawan, New York, are some of the examples of construction in which the Oxford blue sandstone has been employed.

Small quarries producing flagging stone mainly are opened at

South Oxford, Chenango County
Coventry, Chenango County
Smithville Flats, Chenango County
Guilford, Chenango County
Oneonta, Otsego County
Cooperstown, Otsego County

They are worked at irregular times as demand calls for stone.

**Trumansburg, Tompkins County.**— In the vicinity of Trumansburg there are twenty or more quarries which produce four hundred thousand square feet of flagging annually. Two of them only do a little business in building stone, the quarries of D. S. Biggs & Sons and of the Flagstone and Building Stone Company. That of the latter is one mile east of the village and less than a mile from Cayuga lake. The grayish bluestone of the lower course of the quarry is fine-grained, and is cut into lintels, sills and curbing at the company's works at Cayuga, or shipped to their yards at Mott Haven, New York.

The Biggs quarry is on the Taughannock creek about two miles west of the lake and near the Geneva, Ithaca and Sayre

railroad line. The stone here is known as the blue sandstone, and resembles in appearance the Hudson river bluestone, but is harder to work and apparently a little more dense. Stone from this quarry is seen in the large vault in Grove cemetery, Trumansburg. A part of the product is monumental bases.

The stone from these quarries is carried by boats to Cayuga, whence it goes to New York and to cities in the central and western part of the State.

**Ithaca, Tompkins County.**—Nearly all of the stone for foundations and retaining walls, and much of the flagging-stone used in Ithaca, comes from local quarries. There are two quarries on the hill south of the town whence flagging-stone is taken. Some of the stone for the university buildings was quarried on the University grounds. The sandstone of these quarries is of a greenish-gray shade of color, fine-grained, and is durable, when selected with care. The natural-face blocks are often rusty-looking, ironstained, or dirty yellow. Cascadilla Hall is an example of the best of it.

**Penn Yan, Yates County.**—Sandstone for foundation work is quarried near Head street, and on the east side of the lake, three miles north of the village.

**Portage, Livingston County.**—The Portage Bluestone Company's quarry is on the west side of the Genesee river, two miles south of Portageville and three miles from Portage Station, on the New York, Lake Erie and Western railroad. The Western New York and Pennsylvania railroad line is a few rods east of the quarry. The quarry beds have a total thickness of twenty-five feet. The best stone is olive-green in color, fine-grained, homogeneous in texture, and soft enough to dress well and to be easily cut. It is said to harden on exposure to the weather. A representative specimen from this quarry was found to have a specific gravity of 2.695 and equivalent to a weight of 168 pounds per cubic foot. The absorption test indicated 2.97 per cent. of water absorbed; treated with dilute solution of sulphuric acid the loss amounted to 0.42 per cent.; freezing and thawing tests produced slight scaling. In the test, at a temperature of 1200°–1400° F., the color changed to dull red. There were no checks, and the strength of the specimen was but little impaired.

The greater part of the stone quarried here is shipped to New York city, where it is worked up into house trimmings. Some of it is sent to Rochester, where it is cut into dimension stone at the Pitkin yard. The Aldrich Court building, Nos. 41 and 43 Broadway, New York, has Portage stone in the trimmings, in the first and second stories. Some of this stone was used in the United States Government building, at Binghamton.

Warsaw, Wyoming County. — There are two sandstone quarries near this place. The Jameson & Warsaw Manufacturing Company's quarry is two miles west of Rock Glen, on the New York, Lake Erie and Western railroad. It was opened many years ago, but was idle in 1888–9. Some of the stone in the City Hall, Rochester, was taken from this quarry. The Warsaw Blue-Stone Company's quarry is located one-half mile from Rock Glen station, and south of Warsaw; a side track runs from the quarry to the main line of the New York, Lake Erie and Western railroad. The Warsaw bluestone is very fine-grained, harder than the Ohio sandstone, and retains its color on exposure. It has been used for more than thirty years, in Warsaw and vicinity, for monumental bases and buildings.

A specimen from the company's quarry showed a specific gravity of 2.681, equivalent to a weight of 167 pounds per cubic foot. It contains 3.22 per cent. of ferric oxide and .23 per cent. of ferrous oxide. The absorption test gave as a result 2.99 per cent.; the freezing and thawing tests produced slight checking. At the high temperature (1200°–1400°F.) there was a slight vitrification, somewhat of checking, and the color was changed to dull-red. The quarrying plant has been largely increased, and the machinery for sawing and dressing the stone has been set up. The output during the year 1889 was largely in excess of that of any previous year. The principal use of this stone is for house trimmings. The markets are New York city, Syracuse, Elmira, Corning, Binghamton, Philadelphia and Washington. The Alpine, corner of Sixth avenue and Thirty-third street, New York city, the United States Government building, Binghamton and the Colgate Library building, Hamilton College, are more prominent examples of the Warsaw bluestone.

*Chemung Group.*

**Waverly, Tioga County.**—Two quarries are opened and worked at intervals in the vicinity of this place. The stone is blue to gray and rather fine-grained. It has been used in bridge building on the line of the Delaware, Lackawanna and Western railroad, and in several business blocks in Waverly and vicinity.

**Elmira, Chemung County.**—Four quarries have been opened in the sandstone in the western face of the hill which here bounds the valley. The stone is fine grained, and has a gray and greenish-gray color. It is all sold in the rough and used in Elmira for common wall work, and some of it for curbing. The average cost is about $1 a perch in the city.

**Corning, Steuben County.**—There are four quarries in the sandstone at Corning, in the southern outskirts of the town. The stone of these quarries is generally fine-grained, and of a grayish color. It is hard, durable, and does not absorb much moisture, but in consequence of flint-like seams in it, it can not be dressed or fine-tooled economically. The natural-face blocks are often weathered dirty yellow or brown, and hence the need of careful selection of stone. For ordinary wall work and foundations it answers well. The Corning stone has been used in Elmira, in the Congregational church and in the State Reformatory buildings. In Corning, the old arsenal, built about thirty years ago, the Roman Catholic, Protestant Episcopal and First Presbyterian Church buildings are all of this stone. The best example can be seen in the basement-wall of the high school, and in the basement of the residence, near the public school, in which work great care was taken to select large stones and of uniform shade of color.

**Dansville, Livingston County.**—Sandstone for building purposes and for street work is obtained from the quarry, one mile northeast of the village. The stone is bluish-gray in color, fine-grained and hard, but accompanied by much waste rock.

The Chemung sandstone is opened in Steuben county at Cohocton, Bath, Hornellsville, and in the town of Greenwood.

At the **Cohocton** quarry the output is all cut into flagging, which is used in the adjacent towns.

In the town of **Bath** two quarries are worked. The stone is of a light-gray color, fine-grained and rather hard. Curbstone, flagging and common wall stone are obtained from these quarries. The county buildings and the Protestant Episcopal and Baptist churches are built of this stone.

Two quarries are opened and worked in the vicinity of **Hornellsville.** The stone has a bluish color, is hard and fine-grained. The product of these quarries is mostly common building stone, and is cut at Hornellsville. The Park schoolhouse, the electric-light building and several stores and residences are built of it.

In Allegany county sandstone quarries are opened at Belmont, at Belvidere, near Belfast, and in the towns of New Hudson and Cuba. The **Belmont** quarry affords a light-blue stone, which, when cut, has a light gray shade, and is rather soft and easily dressed. The principal markets are Belmont, Wellsville and Angelica. Vanderhoef's block, in Belmont, besides other buildings, are of this stone.

The **Belvidere** quarry is worked in a small way, mainly for the local market. Some of the stone is used at Friendship, Angelica, and a little of it in Wellsville and Hornellsville.

Two miles south of **Belfast** sandstone is quarried to a limited extent for a supply of the town. The Baptist church is constructed of this stone.

Flagstone is quarried in the town of **New Hudson**, near the west line of Belfast. The quarry is worked to a small extent, and its output is considered the best in this part of the State.

**Olean, Cattaraugus County.**— The Olean Bluestone Company quarries a sandstone two and a half miles south of Olean, and about 700 feet above the Allegany river. Stone for building and flagging is obtained and is put on the market as "Olean bluestone." It goes to Buffalo and Rochester. The stone is fine-grained and has a greenish-gray shade of color.

**Jamestown, Chautauqua County.** — There are six small quarries in the eastern part of the town, near the lake outlet. Bedded with the quarry stone there is much shale, and consequently a great deal of waste material has to be removed in quarrying. The bottom beds, from twelve to twenty inches thick, furnish stone for cut work. The stone of the upper strata is used for

rubble work. The Jamestown stone is olive-green in color, fine-grained, soft and breaks with a conchoidal fracture. It has had an extensive use at Chautauqua and in Jamestown, both for foundations and retaining walls and for house trimmings.

Other localities in Chautauqua county are in **Panama**; in the town of **Clymer**; in **Westfield**, near Lake Erie; and at **Laona**, in Pomfret. The quarries at these places are too small and comparatively unimportant for general description.

### Bluestone Quarries of New York by Wm. G. Eberhardt, E. M.

The area in which bluestone is quarried in New York State extends from the west shore of the Hudson river, in Albany, Ulster and Greene counties, in a southwesterly direction through Ulster, Delaware and Sullivan counties to the Delaware river; and there is a small isolated region in Chenango county, in the towns of Oxford and Norwich.

The region has been opened in the towns of Kingston and Saugerties, Ulster county, and Catskill, Athens and Coxsackie, Greene county, at numerous points from which the stone is carted by the quarrymen to the Hudson, where it is bought by various dealers along the lines of the Ulster and Delaware railroad, the Port Jervis and Monticello railroad, the New York, Ontario and Western railroad, the Erie railroad, and the Delaware and Hudson canal. The last-named district extends through the towns of Mamakating, Sullivan county, and Wawarsing and Marbletown, Ulster county. Very little quarrying is done in the district at present.

Of the quarries whose output is shipped *via* the Hudson river the most important are in the town of Saugerties, Ulster county. The quarries in this township are located at Quarryville, West Saugerties, Highwood, Bethel and Unionville. This district has been extensively opened and much stone is produced, although here, as also in the Ulster and Delaware district, the business of quarrying has greatly diminished in recent years. The largest quarries in the town of Saugerties are at Quarryville, about four miles west of the Hudson. The quarries here are on ledges of stone, running parallel to the Hudson up into Greene county. Besides a number of small quarries there are two large openings. One of these is abandoned, owing to inadequate pumping facilities.

Hand and horse-power pumps were used, and found to be of too small capacity to handle the water. The owners intend putting in steam pumps.

About one-half mile north of the village, on the same ledge, is the other opening, in which four parties are engaged in quarrying—Patrick Kelly, Cornelius Harvey, John S. Mower & Co., and A. Carnwright. The total length of the quarry face is about 300 feet. Each quarry employs eight to twelve men, and produces $4,000 to $6,000 in stone per year. No steam machinery is used. Pumps are worked by hand or horse power. The quarries are below the level of the surrounding country, and there is no natural drainage. The water is pumped behind a common dam, extending the length of the workings. The average thickness of the workable bed in these quarries and in the district is about thirteen feet. On this lies a stratum of worthless rock, about three feet thick, which is overlaid by two to twenty feet of earth. The stone is of three grades as to color and hardness. The top layers of the bed are gray and very hard, while those of the bottom are blue and softer. Between these an intermediate grade can be distinguished.

This change in color and hardness occurs in almost all quarries. A bed of bluestone is rarely uniform throughout its entire thickness. Usually the color becomes darker as the distance below the surface and also the distance from the face of the ledge increases. Sometimes, however, the stone is darker in the upper layers. The thickness of the several layers also increases with depth and distance from the face of the ledge. Usually the stone in the second block is about twice as heavy as that in the first. The "lifts" or layers of stone in this district vary from three inches to four feet in thickness. The stone taken from the lower lifts does not stand weathering well. It contains seams and "reeds," invisible seams, which open when the stone is exposed to frost. That from the upper lifts is more compact and durable. The stone is carted to Malden, distant five or six miles by road. The rough stone is worth forty-eight to sixty cents per cubic foot, or four to five cents per inch.

A general description can be given of the method of quarrying throughout the bluestone district, which will apply to all quarries, with the exception of a very few where steam machinery is used.

The equipment consists of sledge hammers, wedges, plugs and feathers, crowbars, shovels, wheelbarrows, and a hand derrick in most of the large quarries. Pumps are rarely necessary. The bed is first stripped of the overburden. The "stripping" of "top," as the overburden is called, is usually earth and worthless stone. In the most favorable case it is simply a layer of earth. The worthless rock may be solid, in which case its removal is an expensive item in quarrying, or it may be very much broken up or shaly (called "pencil stuff"), when it is easily removed. The top rock is removed with the aid of blasting powder and dynamite, and large blasts are sometimes fired when it is heavy. Thirty kegs of powder have been fired in one of these blasts. The stripping is done mostly during the winter, and actual quarrying about nine months in the year.

The beds of stone are divided naturally into blocks by seams and joints at right angles to each other. In the direction of the strike of the ledge are the "side seams," which are very marked, and, where large areas are stripped, may sometimes be seen running straight and truly parallel for several hundred feet without interruption. At right angles to the side seams, and less regular than these, are joints which form two opposite sides of a block. The area of blocks varies greatly. That of large ones may be 1,000 square feet or more. The bed being stripped, the layers or "lifts" of good stone are successively raised by means of wedges driven into the natural bedding planes. Large lifts are broken to desired sizes by plugs and feathers. The plugs are driven home at the same time as the wedges and aid in dislodging the stone from its bed. The thickness of lifts varies from one inch to six feet.

In the Highwoods district the quarries are all small, and worked by two or three men. Two men get out about $1,000 to $1,200 in stone per year. These small quarries are worked until the good stone gives out, or more frequently until the top becomes too heavy to be economically handled on so small a scale. The beds of stone in this district are very uncertain. Layers of shaly rock are interstratified with the good bluestone, and pockets of the same material are irregularly distributed through the beds. The district is said by quarrymen to be nearly exhausted. The stone found here is of a good blue color, hard and heavy. All thicknesses are found up to three or four feet. It is sold to dealers

at Saugerties and Glasco, seven or eight miles distant. The cost of cartage is about $1.75 per 100 square feet two inches thick.

The quarries at West Saugerties, Bethel and Unionville are all small like those in the Highwoods district. The stone is sold to dealers in Malden, Saugerties and Glasco. The stone is also carted to Malden and Saugerties from Palenville, Catskill township, Greene county. This stone is of greenish tint. From Woodstock, also, stone is carted to Malden. Burhans & Brainard have yards and a mill at Saugerties, and the Ulster Bluestone Company at Malden. Other dealers having yards but no mill are, Sweeney Bros. and James Maxwell, at Saugerties, and W. Porter, at Glasco.

In the town of Kingston there are a few small quarries at Dutch Settlement, Hallihan Hill and Jockey Hill, but very little stone is quarried at these places. It is sold to dealers at Wilbur. The Ulster and Delaware railroad has opened up the bluestone country in the towns of Kingston, Hurley, Olive and Shandaken, Ulster county, but the active quarries in this region are much less numerous than in former years. The largest are near Stony Hollow, in Kingston township, and West Hurley, in Hurley township. Some of the stone from these places is carted to Rondout and Wilbur, and some shipped by rail to Rondout. Farther up the road quarries are small and not numerous. Stone is obtained from all stations along the road as far as Allaben, in Shandaken township. Some of the largest quarries are Grant's, Hewitt Boice's and James O'Neill's, at West Hurley. James O'Neill's quarry is situated about one-half mile south of the village of West Hurley, on a ledge running north and south and dipping slightly west. The bed averages about twelve feet, but it is not uniform; about three feet of it is poor stone unevenly distributed through the bed. The stripping varies from five to fifteen feet. The quarry has been opened for about 300 feet, but it worked only on a small scale. The thickness of lifts varies from four to twenty inches. The bottom lifts are of better color than those nearer the top, whose faces are brown, probably from the presence of iron. The stone is shipped by rail to Rondout.

Beside the true bluestone there is a brownish variety quarried at some localities above West Hurley. This is not a handsome stone and not suitable for ornamental purposes.

In the towns of Middletown and Roxbury, Delaware county, a reddish sandstone is found of about the same density and strength as the bluestone of Ulster county. Very little of it is quarried. It is sent to Rondout *via* the Ulster and Delaware railroad. Experiments on bluestone from West Hurley have given the following results: Density, 2.721; crushing st ength, 22.45 pounds per square inch. At Rondout Hewitt Boice has extensive stone yards and a mill. Sweeney Bros. and Julius Osterhoudt have yards and mills at Wilbur.

The bluestone territory has been extensively opened in Sullivan county and to a smaller extent in Delaware county and in the town of Deerpark, Orange county. There are quarries along the lines of the Port Jervis and Monticello, Erie and New York, Ontario and Western railroads in these counties. Along the Port Jervis and Monticello railroad there are quarries at Rose Point, Paradise and Oakland, town of Deerpark, and at Hartwood and Gilmans, town of Forestburg, Sullivan county. They are all small and their output is sold to dealers in Port Jervis who ship it east *via* the Erie. Terbell & Ridgeway, who have a stone yard at Port Jervis, handle most of this stone.

In the valley of the Delaware river, along the line of the Erie railroad, there are quarries in New York State from Deerpark, Orange county, to the town of Sanford, Broome county. In the town of Deerpark there are small quarries at Mill Rift, which sell their output to Louis E. Bliss, New York. At Stairway, Lumberland township, Sullivan county, there are large quarries owned by F. A. Kilgour, which are at present idle, but will be reopened. At Pond Eddy, in the same township, A. H. Woodward operates several quarries and buys the output of others. The quarries on the New York side of the Delaware are not as large or as numerous as those on the Pennsylvania side. The best stone here is more uncertain and of a more pockety nature than that of Ulster county, and the stone is harder. All the stone in the Delaware valley from Deerpark to Callicoon, Delaware township, is quite hard. Beyond this point it becomes gradually softer and is more easily worked. Most of the stone on the New York side at Pond Eddy is shipped to Woodward's mills at Newark, N. J., *via* the Delaware and Hudson canal and the Hudson river, although the freight rates by this route are

one dollar and sixty-five cents per ton as against one dollar and fifteen cents per ton *via* Erie railroad.

Other places in the town of Lumberland at which bluestone is quarried are in the district opposite Parker's Glen, Penn., and Barryville. At the first named of these places the total output is probably less than $100 per month. The stone quarried is suitable only for flagstone. Prices paid for the stone by dealers are from forty-two to forty-five cents per cubic foot or three and one-half to three and three-fourths cents per inch. Very little stone is quarried at Barryville. That district is nearly exhausted.

In the town of Tusten quarrying is carried on extensively opposite Mast Hope, Penn., and at Tusten. Many small quarries are worked at these places, besides a number of larger ones employing ten to fifteen men operated by J. Q. A. Conner & Son of Mast Hope, and C. W. Martin, of Middletown, N. Y. The stone is quite hard, but not uniformly so, and of several shades of blue; but hardness and color are quite uniform in the same quarry. The thickness of lifts varies from one to eighteen or twenty inches. At Mast Hope a reddish stone is quarried, but only true bluestone is found on the New York side of the river at this point. At Narrowsburg, in the same township, there are a number of quarries. Jeremiah Partridge works three quarries at this point. Two of them are within one-fourth of a mile and the third within three-fourths of a mile of the stone docks at Narrowsburg. The stone in all of them is of good blue color and readily worked. The lifts in the farther quarry are heavier and the stone somewhat harder. The owner intends putting steam drills in this quarry. In Cochecton township there are some small quarries at Cochecton village, but only a few of them are being worked.

In Delaware township there are quarries at Callicoon and at Rock Run. The quarry of Persbacker Bros. & Co., at Callicoon, is about one-half mile northwest of the village. During fifteen months that it has been worked about fifty carloads of fifteen to eighteen tons each have been shipped from it. All this stone has been taken from a single block twenty-five by forty-three feet in area. Five men are at work in this quarry. Most of the material taken out is flagstone, but some ten and twelve-inch lifts have been raised. The stone is of good color, bluer in the top

layers than in the bottom, and very hard. The bed has been worked downward twelve feet, below which the depth is unknown. The top is mostly loose earth and varies from two to ten feet in depth.

There are several large quarries at Hankins in the town of Fremont. The largest is operated by Manny & Ross. It is one and one-fourth miles northeast of the village, and employs about twenty men in the active season. A quarry face of 300 to 400 feet in length has been opened, but only a small part of it is worked. The workable bed is twenty to twenty-five feet in thickness. Lifts of all thicknesses up to twenty inches are taken out. The quarry has been worked for eight years and a large quantity of stone is still in sight, but most of it is covered by a very heavy top of rock. The hardness of stone in this locality varies considerably. Louis E. Bliss buys stone at this place.

At Long Eddy and Basket, in the same township, there are extensive workings. Kenney Brothers have a large quarry at Long Eddy, about one fourth of a mile from the railroad. This quarry has been worked three or four years and has yielded 400 to 500 carloads of stone. The bed is eighteen feet deep, and the ledge on which the quarry is situated runs nearly north and south. The top is quite heavy, being mostly rock, twelve to twenty feet deep, but much broken up and easily removed with the aid of powder. Lifts are from one to twelve inches in thickness. The stone is all blue, soft and easily worked. C. W. Martin, F. A. Kilgour and L. E. Bliss get stone from these quarries.

In the town of Hancock, Delaware county, quarrying is carried on very extensively. There are quarries in the Delaware valley at Lordville, Stockport and Hancock, and also on the line of the New York, Ontario and Western railroad. Of the quarries in the Delaware valley, the largest are at Lordville and Stockport. The stone from these places is very well suited for ornamental purposes. It is durable and easily worked. That from Lordville is handled by F. A. Kilgour, Randall & Underwood and Kirkpatrick Bros. The Stockport stone is claimed to be especially free from "reeds," making it well adapted to stand frost and weathering. It is handled by Kirkpatrick Bros., of Hancock. Farther up the valley there are quarries at Hale's Eddy and Deposit, Tompkins township, Delaware county, and also a few

in the town of Sanford, Broome county, along the Erie R. R. At Hale's Eddy all the stone is quarried or bought by O. M. Kingsbury & Co. Randall & Underwood are the most extensive operators at Deposit. The stone from these places is very soft, and of different shades of color, from gray to dark-blue. Some of the gray stone is very coarse-grained.

Along the line of the New York, Ontario and Western railroad there are quarries in Sullivan county in the towns of Liberty and Rockland; in Delaware county, in the towns of Colchester, Hancock, Tompkins and Walton; and in Chenango county, in the towns of Oxford and Norwich. Very little quarrying is done in Liberty township. In Rockland township there are several quarries at Roscoe, the largest of which are worked by Wm. Youman. Farther up the road there are quarries at Cook's Falls, town of Colchester, and in Hancock township at Trout Brook, East Branch, Fish's Eddy and Hancock Junction. The stone from all these places is of very much the same character as to color and hardness. Geo. S. Harris quarries and buys all the stone at East Branch. The quarries at this place are all small. At Fish's Eddy the quarries are larger. Storie & Hollywood work four quarries at this place.

In the town of Tompkins, Delaware county, there are quarries at Apex and Rock Rift. At the latter place E. C. Inderlied has several quarries and a mill. At Walton, Walton township, several quarries are worked. Jas. Nevins & Sons have a quarry and mill on the Delhi division of the Ontario and Western railroad, about four miles from Walton Junction. The mill has been removed from Weehawken to Walton, as it is cheaper to ship the stone dressed than in the rough state. The workable bed in the quarry is thirty feet in thickness and is covered by a light top. The F. G. Clarke Bluestone Company quarries extensively in the town of Oxford, Chenango county. The quarries of this company are located at Oxford and at Coventry, four miles to the southwest of Oxford, on the Delaware, Lackawanna and Western railroad. The stone from both places is dressed at the mill of the company at Oxford. The thickness of the bed in the Oxford quarry is sixteen feet. The top is very heavy, consisting of about forty feet of loose earth and twenty-five feet of solid rock. In order to make a profit under such un-

favorable conditions, the quarry is worked on a large scale, and steam machinery is employed in quarrying and handling the stone. A channeling machine is part of the equipment. The stone is handled in the quarry by derricks worked by steam, and is taken out by carts and a wire tramway. The stone is of very fine quality. Its color is a good blue and very uniform throughout the bed. It is softer than Ulster county stone and easily worked, which makes it desirable for ornamental purposes. The lifts are too heavy for small flagstones, but many large ones, measuring from fifteen to twenty feet or more on a side, are taken out. Stone up to six feet thick can be obtained at this quarry. Powder is used instead of plugs and feathers in getting out large blocks. Deep holes are drilled with steam drills and reamed out, making a hole about two inches in diameter. A small charge is placed in each hole, which is tamped so that the force of the explosion is exerted against an elastic cushion of air, and the block is thus loosened from its bed without unnecessary splitting. The charges are fired simultaneously by electricity. This method is found more satisfactory than channeling.

Stone is quarried at Norwich for local and foreign consumption. A very dark stone is quarried here which is valuable for ornamental purposes.

## Triassic or New Red Sandstone.

**Nyack, Rockland County.** — Two quarries, located on the shore of the river, are worked more or less steadily; one by Daniel T. Smith, the other by Nelson Puff. The stone of these quarries is worked into lintels, sills and platforms. The product is mainly for the local market.

**Haverstraw, Rockland County.** — The sandstone quarries at Haverstraw are worked only at long intervals, and then for common building stone which is used in the place.

Formerly these Nyack and Haverstraw quarries were worked on a large scale, and stone for building was shipped thence to New York and cities along the Hudson valley.

The house still standing near the Smith quarry, which was built in 1768, shows the durable nature of the stone. The Cornelius house in Nyack is another example.

## GLACIAL DRIFT

This formation, consisting of unsorted clays, sands, gravels, cobbles and boulders, is found in all parts of the State. The nature of the imbedded stone varies greatly both as to variety and amount. In places the deposits are full of large blocks of stone and of more or less rounded and scratched boulders; in other localities the hard, quartzose cobbles and small boulders predominate. In the sandstone districts of the southern and western parts of the State the surface deposits of glacial drift contain much sandstone, as in the Medina sandstone belt, the Hudson River bluestone territory and the red sandstones at Haverstraw and Nyack In the Highlands and in the Adirondacks the rounded, crystalline, granitoid and gneissic rocks predominate. On Long Island the terminal moraine includes a great amount of stone, and of many kinds.

The cobblestones were formerly used for paving roadways, but this kind of pavement is no longer laid. From the fact of the stone being picked off the fields in the clearing of land for tillage, the stone of the drift has been known as "field-stone;" and they were used in the earlier constructions for walls, foundations and buildings, in localities where no quarries had been opened, and even before resort was had to quarry stone

Some of the oldest houses on the western end of Long Island, and in the Hudson River counties are built of such field stone. At Yonkers the excavations for foundations and in street grading afford an abundant supply of stone for common wall work. In parts of Brooklyn the drift furnishes a great deal of stone in the shape of huge boulders.

The stone of the drift is generally hard and durable, having resisted the wear of rough transportation. The economic use of the surface stones of the drift in constructive work, where they can be laid up in walls, is a desirable utilization of what is still in many parts of the State worse than waste — a nuisance in the tilling of the soil. This formation can not, however, be considered as one of the important sources of stone in the quarry industry, although capable of yielding a great deal of rough stone. It will no doubt do so in the future clearing and improvement of the country.

## SLATE

Argillite or clay-slate, which is marked by the presence of cleavage planes, and can be split into thin plates of uniform thickness — roofing slate — is a characteristic rock in the Hudson River group and the Lower Cambrian or Georgia group.

Slate suitable for roofing has been found in many localities, and quarries have been opened in Orange, Dutchess, Columbia, Rensselaer and Washington counties. The openings in Orange county have not resulted in productive quarries. In Columbia county quarries were worked many years ago, east of New Lebanon.* The Hoosick quarries, in Rensselaer county, were more extensively worked, and produced a good, black slate. Outcrops of red slate are noted east of the Hudson, from Fishkill and Matteawan northward, but no attempts have been made to open quarries in them.

The productive slate quarries of the State are in a narrow belt, which runs a north-northeast course through the towns of Salem, Hebron, Granville, Hampton and Whitehall, in Washington county.

This slate belt is divided by the quarrymen into four parallel ranges or "veins," which are: East Whitehall red slates; the Mettowee, or North Bend red slate; the purple, green and variegated slates of Middle Granville; and the Granville red slates. The latter is close to the Vermont line. Further to the east, but over the State line, in Vermont, is the range of the sea-green slates.

The quarry localities are at Shushan, Salem, Black Creek valley, in the town of Salem, Slateville, in Hebron, Granville, the Penrhyn Slate Company's quarries, Middle Granville, Mettowee or North Bend quarries, and the Hatch Hill quarries in East Whitehall.

The quarries of Washington county have not yet been worked down to as great depth as some of those in Northampton and Lehigh counties, in Pennsylvania, and the deepest has not reached a vertical depth of 100 feet.

The quarries at the southwest, in Shushan and Salem, produce purple, variegated and green-colored slates. At Salem some

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* Wm. W. Mather, Geology of the First Geological District, Albany, 1843, pages 419-421.

stone for flagging and foundation work is obtained. At the quarries west and northwest of the village of Salem, and at Slatesville, in Hebron, the slate is red.

The principal range of red slate is that which runs from Granville north — passing east of Middle Granville. It is narrow, being in places less than thirty rods wide. There are numerous openings in it, and it has yielded a large amount of red, and some unfading green, roofing slate.

In Middle Granville the purple, green and variegated varieties are found. North of the village, a quarter to three-quarters of a mile, are the large openings of the Penrhyn Slate Company, which produce purple, unfading green and variegated (green and purple) slates. A large part of the output of these quarries is worked up in their mills into plain, marbleized, decorative and enameled material, as mantels, steps, house trimmings, table tops, laundry tubs, wainscoting and floor tiles.

The Mettowee or North Bend quarries, three and a half miles north of Middle Granville, are worked by two companies. Their product is a red roofing slate.

The Hatch Hill group of quarries is six miles southeast of Whitehall. There are four openings.

The slate is of a bright-red color. A part of it is split at the quarry into roofing material. Perhaps an equally large amount is cut into floor-tiling, billiard table tops and house trimming materials. These quarries are much deeper than those of the Granville red slate range, and the slate has a brighter red color, and is more easily worked than that of the latter range.

Their product, mostly finished stock, has to be carted by teams six miles to Whitehall or to Middle Granville, shipping points.

The green slate of these Washington county quarries is almost all of the unfading variety, which is more durable and more valuable than the sea-green slate. The variegated (purple and green) also is durable, but is softer and less valuable than the red, which is esteemed for roofing and tiling purposes.

The purple and green slates are more abundant, and are used more for marbleizing.

A specimen of the red roofing slate of Washington county was tested and found to have a specific gravity of 2.84, equivalent to a weight of 177 pounds per cubic foot. It contained 1.87 per

cent. of ferrous oxide and 7.36 per cent. of ferric oxide. Its absorptive percentage was 0.15. It lost 0.07 per cent. in weight in the sulphuric acid solution test. It remained unchanged in tests of alternate freezing and thawing.

The estimated production of red roofing slate in 1889 was 5,000 squares. The ruling prices per square were as follows:*

| | | |
|---|---|---|
| Red | $8 00 to | $10 00 |
| Purple | 3 50 to | 4 00 |
| Unfading-green | 3 50 to | 4 00 |
| Sea-green | 2 75 to | 3 00 |
| Variegated | 2 50 to | 2 75 |

NOTE.— A recent bulletin of the United States Census gives a list of firms producing slate, and the statistics of production, labor, wages, etc. According to this report there are sixteen quarries in this State, which produced in 1889 17,167 squares of roofing slate, and slate for other purposes valued at $44,877, making a total value of $130,603.

## LIMESTONE AND MARBLE

Limestones consist essentially of calcium carbonate. They are, however, often quite impure; and the more common accessory constituents are silica, clay, oxides of iron, magnesia, and bituminous matter. And these foreign materials may enter into their composition to such an extent as to give character to the mass, and hence they are said to be silicious, argillaceous, ferruginous, magnesian, dolomitic, and bituminous.

The chemical composition is subject to great variation, and there is an almost endless series of gradation between these various kinds of varieties. Thus, the magnesium carbonate may be present, from traces, to the full percentage of a typical dolomite. Or, the silica may range from the fractional percentage to the extreme limit where the stone becomes a calcareous sandstone. Crystallized minerals, as mica, quartz, talc, serpentine and others, also occur, particularly in the more crystalline limestone.

In color there is a wide variation—from the white of the more nearly pure carbonate of lime through gray, blue, yellow, red, brown, and to black. The color is dependent upon the impurities.

The texture also varies greatly. All limestones exhibit a crystalline structure under the microscope, but to the unaided eye there are crystalline and massive varieties. And there are

* Letter of Hugh Williams of Middle Granville, January 22, 1890.

coarse crystalline, fine crystalline, and sub-crystalline, according as the crystals are larger, smaller, or recognized by the aid of a magnifying glass only. The terms coarse-grained and fine-grained may apply when there is a resemblance to sandstone in the granular state of aggregation. Other terms, as saccharoidal (like sugar), oolitic, when the mass resembles the roe of a fish; crinoidal, made up of the stems of fossil crinoids, also are in use, and are descriptive of texture. The state of aggregation of the constituent particles varies greatly, and the stone is hard and compact, almost like chert, or is loosely held together and crumbles on slight pressure, or again it is dull and earthy as in chalk.

The crystalline, granular limestones, which are susceptible of a fine polish, and which are adapted to decorative work, are classed as *marbles*. Inasmuch as the distinction is in part based upon the use, it is not sharply defined and scientific. Generally the term is restricted to those limestones in which the sediments have been altered and so metamorphosed as to have a more or less crystalline texture. There is however some confusion in the use of the terms, and the same stone is known as marble and limestone, e. g., the Lockport limestone or marble; the limestone and coral shell marble of Becraft's mountain, near Hudson; the Lepanto marble or limestone near Plattsburg, and others.

The fossiliferous limestones are made up of the remains of organisms which have grown in situ, as for example, the coralline beds in the Helderberg and Niagara limestones, or have been deposited as marine sediments. In the case of the latter the fossils are more or less comminuted and held in a calcareous matrix. Generally the fossil portions of the mass are crystalline. The Onondaga gray limestone from near Syracuse, and the Lockport encrinital limestone are good examples.

The fossil remains are less prominent and scarcely visible in some of the common blue limestones, as in the lower beds of Calciferous and in some of the Helderberg series. These rocks are compact, homogeneous and apparently uncrystalline and unfossiliferous. They are usually more silicious or argillaceous, that is, they contain quartz or clay, the latter often in seams rudely parallel with the bedding planes. On weathering, the difference in composition is often markedly apparent at a glance. Similar differences in composition are seen

in the more crystalline marbles, and are evident either by variation in color, or in the presence of foreign minerals, as mica, quartz, hornblende, pyrite, etc.

The variation in the strength and durability is as great as in the composition and texture. Some are stronger than many granites in their resistance to crushing force, and equally enduring; others consist of loosely cohering grains, and are friable and rapidly dissolved by atmospheric agencies. The more silicious and compact limestones are generally the more durable and stronger; in the marbles the well-crystallized and more homogeneous texture consists with endurance and strength. Both the magnesian and dolomitic varieties are good stone as is proven by the Calciferous and the Niagara limestones, and in the marbles of Tuckahoe and Pleasantville, in Westchester county.

Crystalline limestones occur in New York city and Westchester county, and in the Highlands of the Hudson. In the Adirondack region there are numerous localities. The rock in many of them is too impure and has too many foreign minerals to admit of its use as marble. Quarries have been opened in Westchester, Putnam and Dutchess counties, which have yielded a large amount of fine white marble. In the northern part of the State, the Port Henry and the Gouverneur quarries have been productive. The geological horizon of some of these marbles is in doubt. The belt in the eastern part of Dutchess and Putnam counties belongs to the Vermont marble range, and is probably metamorphosed Trenton limestone. The Westchester marbles may be of the same age.

The limestones which furnish building stone in this State are the Calciferous, Chazy, Birdseye, Black River, Trenton, Niagara, Lower Helderberg, Upper Helderberg, or Corniferous, and Tully. The geographical distribution is given in the following notes, and in the order of geological succession, from the lowest to the highest.

### Calciferous Sandrock.

The rocks of the Calciferous formation in the Mohawk valley and in the Champlain valley are more silicious than at the southwest, in Orange county and in the Hudson valley, and hence the designation as a sandrock. Much of it at the north is a limestone rather than a sandstone, and may be termed a magnesian or silicio-

magnesian limestone. Nearly all of the limestones, which are quarried for building stone, in Orange and Dutchess counties are from this formation. The stone occurs generally in thick and regular beds. It is hard, strong and durable and is adapted for heavy masonry as well as for fine cut work. The quarries near Warwick, Mapes' Corners and near Newburgh in Orange county and those on the Hudson River, near New Hamburg, are in the Calciferous. The Sandy Hill quarry and those at Canajoharie and Little Falls are also in it.

### Trenton Limestone.

Under this head the Chazy, Birdseye, Black River and Trenton limestones are included.

The Chazy limestone crops out in Essex and Clinton counties and in the Champlain valley — its typical localities. The beds are thick and generally uneven. Regular systems of joints help the quarrymen in getting out large blocks. Quarries at Willsboro Point and near Plattsburg are in the horizon of the Chazy. The stone is suitable for bridge work and for heavy masonry.

The members of the Trenton above the Chazy limestone are recognized in many outcrops in the southeastern part of the State; in the Hudson-Champlain valley; in the Mohawk valley; in the valley of the Black River and northwest, bordering Lake Ontario; and in a border zone on the north of the Adirondacks, in the St. Lawrence valley. In a formation so widely-extended there is, as might be expected, some variation in bedding, texture and color. Much of the Trenton limestone formation proper is thin-bedded and shaly and unfit for building stone. In the Birdseye also the stone of many localities is disfigured on weathering, by its peculiar fossils. Generally the stone is sub-crystalline, hard and compact and of a high specific gravity and dark-blue to gray in color. But the variation is wide, as for example, between the black marble of Glens Falls and the gray, crystalline rock of the Prospect quarries near Trenton Falls. The variation is often great within the range of a comparatively few feet vertically; and the same quarry may yield two or more varieties of building stone. In several quarries the Birdseye and Trenton

are both represented. Many quarries have been opened in the formation and there are many more localities where stone has been taken from outcropping ledges, which are not developed into quarries proper. The more important localities which are worked steadily are: Glens Falls, Amsterdam, Tribes Hill, Canajoharie, Palatine Bridge and Prospect in the valley of the Mohawk; and Lowville, Watertown, Three Mile Bay, Chaumont and Ogdensburg in the Black River and St. Lawrence valleys. The railroad and canal lines, which traverse the territory occupied by these formations, afford transportation facilities and offer inducements to those who are seeking new quarry sites where these limestones may be found in workable extent.

### Niagara Limestone.

The Niagara limestone formation is well developed west from Rochester to the Niagara river; and there are large quarries in it at Rochester, at Lockport and at Niagara Falls. The gray, sub-crystalline stone in thick beds is quarried for building purposes. It is filled with encrinital and coralline fossils and the unequal weathering of the matrix and the fossiliferous portions are sometimes such as to give the dressed surface a pitted appearance with cavities which roughen and disfigure it. For foundations and heavy masonry it is well adapted. It has been extensively employed in the western part of the State.

### Lower Helderberg Limestones.

The Water-lime, Tentaculite and Pentamerus limestones are included in this group. The outcrops are in the Rondout valley, southwest from Kingston to the Delaware river; in the foothills east of the Catskills — in Ulster and Greene counties; on Becraft's mountain, near Hudson; and in a belt stretching west from the Hudson valley, along the Helderbergs and across Schoharie into Herkimer county.

The Tentaculite limestone is dark-colored, compact and in thick beds and can be quarried in large blocks. Some of it can be polished and makes a beautiful black marble, as for example, that of Schoharie.

The Pentamerus limestones, both the lower and the upper, are in thick beds and are gray, sub-crystalline in texture, and look

well when dressed. They are adapted to heavy masonry as well as for cut work.

Quarries are opened in this group of limestones in the Schoharie valley, at Howe's Cave, Cobleskill, Cherry Valley and in Springfield. The quarries west of Catskill and in Becraft's mountain, near Hudson, are also in it.

### Upper Helderberg Limestones.

The Upper Helderberg formation appears in the Hudson valley at Kingston; thence it runs in a belt west of the river, to the Helderberg mountains, bending to the west-northwest, and then west it continues across the State to the Niagara River and Lake Erie. The subdivisions are known as the Onondaga, the Corniferous and the Seneca limestones. The first is more generally recognized as the "Onondaga gray limestone" and the last as the Seneca blue limestone.

There is much diversity in the limestones of this group in its long range of outcrop. The Onondaga gray stone is gray in color, coarse crystalline; and makes beautiful ashlar work, either as rock face or as fine tooled, decorative pieces.

The Corniferous limestone is hard and durable, but it is so full of chert that it can only be used for common wall work.

The Seneca blue limestone is easily dressed and is a fairly good building stone.

Limestone of the Upper Helderberg epoch is quarried extensively at Kingston, Ulster county, and is a valuable building stone. In Onondaga county there are the well-known Splitrock and Reservation groups of quarries, which have produced an immense quantity of excellent and beautiful stone and which has found a market in all of the central part of the State. They are in the lower member of the group. Going west, there are the large quarries in the Seneca limestone at Union Springs, Waterloo, Seneca Falls and Auburn. The LeRoy, Williamsville, Buffalo and Black Rock quarries are in the Corniferous limestone.

The aggregate output of the quarries in the Upper Helderberg limestones exceeds in value that of any other limestone formation in the State. The many quarries of the Trenton probably produce more stone.

### Tully Limestone.

The Tully limestone lying above the Hamilton shales, is a thin formation which is seen in Onondaga county and to the west — on the shores of Cayuga lake — in Seneca county and disappearing in Ontario county. It does not furnish any stone other than for rough work and in the immediate neighborhood of its outcrops.

### Calcareous Tufa

As a supplement to the limestones the quarry in calcareous tufa at Mohawk, in the Mohawk valley, should here be mentioned, although the quarry is of no importance and there is no outcrop large enough for much work in it.

## DESCRIPTION OF MARBLE AND LIMESTONE QUARRIES

### *Marbles*

**New York City.**—A white, crystalline limestone was formerly quarried at Kingsbridge and used in the construction of buildings in the city. The same limestone is now exposed in the deep cut made for the Harlem ship canal. Crystalline limestone has been quarried at Morrisania and Mott Haven also, but they can scarcely be called marbles in a proper sense, although used for ordinary construction.

**Tremont, New York City.**—Four quarries have been opened in the white marble in Tremont, and worked for house trimmings and ordinary construction. The Tremont marble can be seen in the new buildings of St. John's College, Fordham, where it has been used effectively with the dark-blue gneiss. The output of these quarries is small and unimportant.

**Tuckahoe, Westchester County.**—The Tuckahoe Marble Company and the New York Marble Company quarry marble at Tuckahoe. The first-named company works what was formerly known as Young's quarry. The latter company has a large quarry adjoining it on the north. The stone of these quarries is coarsely-crystalline in texture and pure white. In composition it is a true dolomite. A sample from the New York Quarry Company (J. M. Masterton) was found to contain

30.63 per cent of lime, and 20.77 per cent. of magnesia, and 0.91 per cent. of insoluble matter. The specific gravity was 2.868, equivalent to 178 pounds per cubic foot. The absorption test indicated 0.14 per cent. of water absorbed. The loss in weight when acted upon by sulphuric acid gas amounted to 0.25 per cent Freezing and thawing produced no apparent change. At a high temperature the specimen was calcined and crumbled at the touch. The Tuckahoe quarries have been worked since 1820, and have produced a large aggregate of marble, which has been put in large and expensive buildings in cities along the Atlantic coast from Boston to New Orleans. It is comparatively durable and resists the action of the weather better than much of the Vermont and the foreign marbles, which have been used in New York city. A noticeable change from long exposure is a slight yellowish shade of color, which can be seen in the United States Assay Office building, Wall street, in the building of the National Shoe and Leather Bank, and in the houses of the cardinal and of the archbishop on Madison avenue. Some of the more prominent structures in which Tuckahoe marble has been used are the following: The United States Post-Office, United States Naval Observatory and the Soldiers' Home, Washington, D. C.; the City Hall, Brooklyn; the A. T. Stewart buildings on Broadway and Fifth avenue, New York, and the Sears building, Vendome Hotel and Revere Bank in Boston.

**Pleasantville, Westchester County.**—The Snowflake Marble Company's quarry is one mile southeast of the village of Pleasantville. This marble is white and very coarse-crystalline. It is much harder than the Vermont marbles and does not compete with them for monumental work. The chemical analysis shows it to be a dolomitic limestone or marble. Examples of its use are: St. Patrick's Roman Catholic Cathedral, Fifth avenue, and the Union Dime Savings building, Sixth avenue and Thirty-second street, New York city; also the Methodist Episcopal church in Sing Sing.

**Hastings, Westchester County.**—The marble quarries near Hastings produce a white, fine-crystalline, dolomitic stone. They have been idle for many years.

**Sing Sing, Westchester County.**— The crystalline limestone east of the State prison and on the State property was formerly worked for marble; and the prison buildings and the State Hall at Albany are built of stone which came from these quarries.

White limestone in the Dover Plains — Patterson valley has been opened at several points between Patterson on the south and Dover Plains on the north, and a white marble has been obtained and worked up largely for monumental bases and gravestones. The stone of these quarries is bluish white and fine-crystalline in texture and is readily dressed. They have been idle for several years past.

**Towner's Four Corners, Putnam County.**— The old quarry at this locality was opened two years ago for stone to be used in the construction of the Sodom dam. The stone is gray and white, rather coarse-crystalline and contains many crystals of white pyroxene scattered through the mass. The friable and decomposed condition of the ledges near the quarry leads to the belief that the stone is not very durable.

**Gouverneur, St. Lawrence County.**— At Gouverneur there are three companies working marble quarries. The works and quarries are located about one mile southwest of the village and near the R., W. & O. railroad line. There are two leading varieties of stone obtained in these quarries; a light gray at the top and a dark-blue at the bottom. The latter resembles, when dressed, some of the gray granites. Both varieties are coarse-crystalline in structure. A specimen from the St. Lawrence Marble Company's quarry was found to have a specific gravity of 2.756, equivalent to a weight of 171 pounds per cubic foot; 51.57 per cent. of lime, 3.29 per cent. of magnesia and 1.29 per cent. insoluble matter. The absorbed water amounted to 1.16 per cent. The loss, when acted upon by sulphurous acid gas, was 0.15 per cent.; freezing and thawing produced no apparent change. At a high temperature, (1200°–1400°) the specimen was fully calcined.

"The Gouverneur marble was employed at least fifty years ago for gravestones, and in the Riverside cemetery, at Gouverneur, these old gravestones, bearing dates from 1818 onward, can now be seen. As compared with the white marble headstones from Vermont it is more durable; and there is not so luxuriant a growth of moss and lichen as on the latter stone, but in the

case of the older Gouverneur stone some signs of decay and disintegration, particularly on the tops, are noticeable, and small pieces can be chipped off with the knife blade. The durability of the stone for building purposes has been tested in some of the older structures in Gouverneur."

The leading use of the Gouverneur marble is for monuments. A large amount is sold for rock-ashlar, for buildings, principally to western markets. It may be seen in several business blocks in Gouverneur; Hubbard House, Malone; in the Presbyterian church, Canton; in the Flower Memorial Chapel, Watertown; and the State Asylum for the Insane at Ogdensburg, and Merrick block, Syracuse.

Canton, St. Lawrence County.— A grayish-white marble is opened in this town, four miles easterly from Canton. It has not been worked lately.

### Verd-Antique Marble.

Thurman, Warren County.— The verd-antique marble locality is open in this town, eight miles northwest of Thurman, and five miles from Glendale station. The quarry was worked for three years and then abandoned. The stone is of a yellowish-green color and not the deep rich green, characteristic of precious serpentine.

Bolton, Warren County.— Localities of serpentine marble are known in this town, but they have not been developed into quarries.

Port Henry, Essex County.— The Burlington Manufacturing Company has a quarry of verd-antique marble about one-quarter of a mile north of the Cheever ore bed. The stone is coarse-granular, green and white, speckled, in color and is capable of taking a good polish. The place has been idle since 1886.

### Limestones.

Warwick, Orange County.— The blue, magnesian limestone formation here affords a good building stone for the local supply, and the quarries are worked at intervals, according to the demand.

Mapes Corner, Orange County.— The quarries on Mount Lookout near Orange Farm station of the Pine Island Branch railroad furnish stone to Goshen, Chester and the adjacent country. The stone occurs in thick beds and is adapted for massive wall work. The Presbyterian, Methodist Episcopal and Roman Catholic churches in Goshen and the Roman Catholic church in Chester are examples in construction.

Newburg.— Blue limestone is quarried southwest of the city, near the old Cochecton turnpike, and on the north slope of Snake Hill. It has been used largely for retaining walls and foundations in the city. St. George's Protestant Episcopal Church is built of stone from this range. North of the city there is a small quarry on the river road.

New Hamburg, Dutchess County.— The quarry, two miles north of New Hamburg, is worked for bridge stone for the N. Y. C. & H. R. R. R. Co. and for ballast.

Kingston, Ulster County. — The outcrops of the Onondaga limestone formation in the city have afforded stone for building from the earliest settlement of the place, and the old stone-houses are in part built of this stone. Quarries have been opened from the Kingston and Rondout railroad on Main street, and near Union avenue southwest to the cemetery, and near Washington and Pearl streets in the western part of the city. The beds are from two to eight feet thick. Two well-marked systems of vertical joints divide the rock into blocks of a size convenient for quarrying. Freshly-fractured surfaces of this limestone are of a dark-blue shade; weathered surfaces are gray, in some cases brown-yellow. Thin seams of argillaceous or more clayey rock, from one-sixteenth to one-fourth of an inch, alternating irregularly with the calcareous portions, cause unequal wear in exposed faces and develop lines of dirty yellow in the gray background of the stone, which are unsightly. They do not, however, impair seriously its strength or durability, except when the stone is set on edge. Some chert and scattering crystals of pyrite occur in some of the surface beds, but the lower and thicker beds appear to be free from these minerals. The stone is best adapted for foundations and for heavy masonry as it is hard, dense, very strong and to be had in large blocks. These quarries have furnished the great bulk of stone used in Kingston. The piers of the Pough-

keepsie bridge ; part of the anchorage and piers of the New York and Brooklyn bridge ; locks at Cohoes and Waterford, and St. Patrick's Roman Catholic Church in Newburgh are examples of the Kingston limestones. These quarries are not worked continuously.

**Greenport, Columbia County.**— The quarries near Hudson in the town of Greenport are opened on the north end, and in the western escarpment of Becraft's mountain. Geologically they are in the Upper Pentamerus and Encrinal limestone divisions of the Lower Helderberg horizon and the stone is a nearly pure carbonate of lime. It is gray to reddish gray in color, sub-crystalline to crystalline and highly fossiliferous. The beds are from four inches to six feet thick, and afford blocks of large size. The stone is susceptible of a high polish, and is adapted to decorative purposes, preferable for interior work. It has been known as "coral-shell marble" and "scutella marble." Nearly all of the foundations and retaining walls in the city of Hudson are of this stone. The Presbyterian church is a good architectural example of its use. The quarries of F. W. Jones are worked continuously and the railroad connects them with the New York Central and Hudson River railroad and the river.

*Champlain Valley.*

**Saratoga Springs, Saratoga County.**— Blue limestone for common masonry has been quarried at several places in the town.

The largest quarries are those of Charles G. Slade and Isaac F. Wager, about three miles west of the village. The geological horizon is Calciferous and Trenton.

The stone is of a dark-blue shade. That of the thick beds is rather easily dressed and is worked up into dimension blocks for curbing, and house-trimming and heavy bridge work on the Delaware and Hudson Canal Co.'s railroad lines. It has to be carted to Saratoga, where a large part of the total output is used in house-work.

**Sandy Hill, Warren County.**— The Sandy Hill Quarry Company has extensive quarries two miles from the Sandy Hill railroad station, and a half mile northeast of the canal.

The formation is that of the calciferous sand rock. A large area has been worked over to a slight depth. There is a thin covering of earth from one to two feet thick; then quarry beds one to seven feet thick, down at least to forty feet. The dip is less than five degrees to the south.

Open and vertical, dirt-filled joints are a peculiar feature and facilitate the removal of huge blocks. The long working face and natural drainage are also advantages. And with a complete equipment of steam drills, derricks and movable railways, the capacity of production is large. The annual output in cubic yards is greater than that of any other single building-stone quarry in the State, and is increasing from year to year.

The stone is of a light blue color, and fine-grained. Its specific gravity is 2.764 and its weight per cubic foot 172 pounds. A partial chemical analysis gave 27.35 per cent of matter insoluble in dilute hydrochloric acid. The lime and magnesia are present in proportions approximating to a dolomite. The absorption capacity was found to be 0.14 per cent. When treated with a 1 per cent. solution of sulphuric acid the loss in weight was 2.51 per cent. Freezing and thawing did not produce any apparent effect. Exposed to a heat of 1200° to 1400° F. the stone was partially calcined and crumbled with a blow. On account of its hardness, it can not be dressed economically, and very little of it is used for housework. It is specially adapted to heavy masonry. It was used in the Arthur Kill bridge on Staten Island sound, in the rear wall on Governor's Island, in the walls of the sunken track of the Harlem railroad, in the Croton aqueduct gatehouse, New York city, the Poughkeepsie bridge piers, and in the battle monument at Bennington, Vermont.

**Glens Falls.**— There are two large quarries in the Trenton limestone, one on each side of the Hudson river at Glens Falls. That of the Morgan Lumber and Lime Company on the Saratoga county side is no longer worked for building stone. The quarry on the left bank, in Warren county, belongs to the Glens Falls Company, and is worked for black limestone or "marble."

There is a long working-face in which a gray, crystalline limestone is seen in thin beds at the top, then the black marble, which has, in two beds, a total thickness of twelve feet.

The gray limestone is sold in the rough for common wall work, or cut into house-trimming material.

The black marble is fine-grained and compact, hard and brittle, but can be dressed in any style. It takes a brilliant polish and is jet black. Its specific gravity is 2.718 and its weight per cubic foot 169.4 pounds. According to analysis it is a magnesian limestone, carrying a high percentage (30.18) of matters insoluble in hydrochloric acid. The percentage of water absorbed is relatively low, 0.08. The specimens remained unchanged in the tests by alternate freezing and thawing. At a high heat (1200°–1400°) the stone was calcined and crumbled to the touch.

For tiling it is particularly well adapted, as it does not wear slippery. It is worked up in a mill at the quarry, and tiles, shelves, mantels, lintels, coping-stone, wainscoting, billiard table tops and material for all inside, decorative work, are cut. Among the examples of inside work, the building of the Equitable Insurance Company, Broadway, New York, is perhaps the best. The market for it is all over the country.

The quarry is at the side of the Champlain canal (feeder) and one half mile from the Delaware and Hudson Canal Company's railroad.

**Whitehall, Washington County.**— The quarry of the Arana Marble Company at the side of the railroad, about half way between Whitehall and Fair Haven, has not been worked except for stone for flux in iron furnaces

**Crown Point, Essex County.**— The quarries in this town have not been worked recently.

**Willsboro Neck, Essex County.**— The Chazy limestone on this Neck, has been opened in two large quarries. A large business was done in 1854 and thereafter for about twenty years, and much of the stone was used in the foundations of the Capitol at Albany, and in those of the New York and Brooklyn bridge.

The stone can be seen in the Reformed Church, Swan street, Albany, and in the State Street M. E. Church in Troy. It has been known in the market as "Lake Champlain bluestone." The stone is light-blue in color, weathering to a light-gray.

The light stripping necessary to open the quarries, the uniform thickness of the beds, the regular, vertical joints, and the loca-

tion on the lake accessible by boats, are notable advantages. One quarry only is now worked and that in a small way.

**Plattsburg, Clinton County.**— In the vicinity of Plattsburg there are several small quarries in the Chazy limestone which furnish stone for construction in the town. The St. John's Roman Catholic Church and the First Presbyterian Church are built of this stone.

South of Plattsburg three and a half miles, the Burlington Manufacturing Company has a quarry where a limestone is obtained, which is known in the market as "Lepanto marble." It is fine-crystalline in texture, gray to red in color, and takes a high polish. The specific gravity is 2.709, and its weight per cubic foot is 168.8 pounds. It contains 1.54 per cent. only of matter insoluble in dilute hydrochloric acid and 94.87 per cent. of calcium carbonate. The absorption test showed 0.145 per cent. of water absorbed. In freezing and thawing there was no change, but at a high heat the stone was fully calcined and crumbled to the touch.

The stone has to be hauled by teams to the lake, one mile east of the quarry. It is dressed at the company's works in Burlington, Vermont.

The principal markets for it are Burlington and Plattsburg.

*Mohawk Valley.*

In Schenectady county there are two small quarries on the south side of the Mohawk river, and near **Pattersonville** station, which are worked at infrequent intervals for the local market. They are in the horizon of the Trenton limestone.

**Amsterdam, Montgomery County.**— The Birdseye limestone and the Trenton limestone outcrops in the valley of the Chuctanunda creek afford sites for quarrying building stone, and four quarries have been opened north of the town of Amsterdam, and at a height of 180 to 250 feet above the Mohawk valley. The stone is in beds from six inches to three feet thick which are almost horizontal. The rough stone is sold for making lime, the best is cut into platforms, sills, lintels, and house-trimming materials. The principal markets are Amsterdam, Albany, Cohoes and Troy. Shanahan's quarry furnished a large amount

of stone for the foundation of the Capitol at Albany. The other quarries are Hewitt's and Vanderveer's.

Tribes Hill, Montgomery County.—There are two large quarries near the station of the N. Y. C. & H. R. R. R. at Tribes Hill: that of Henry Hurst & Son, a few rods west of the depot, and one east of it, belonging to James Shanahan. The former is worked steadily and mainly for constructions in the neighboring towns; the latter has been idle for several years.

The upper strata in both quarries are of blue limestone suitable for common rubble work or for lime making. The graystone of the thicker and lower beds is fine-crystalline to sub-crystalline in texture, and having a specific gravity of 2.718. The computed weight per cubic foot is 169 pounds. It contains, according to analysis, matters insoluble in dilute hydrochloric acid 2.48 per cent, and of lime 53.57 per cent. or equivalent to 95.68 per cent., of calcium carbonate. The absorption percentage was found to be 0.14. Freezing and thawing produced no change. At a red heat it was reduced to lime.

The markets for Tribes Hill limestone are Albany, Troy, Cohoes, Stillwater, Mechanicville, Hoosick Falls, Johnstown and Gloversville.

The Edison House, Schenectady, is an example in construction.

Fine-tooled surfaces are of a light-gray shade of color; polished, it looks almost like a black marble.*

Quarries have been opened at many points in the valley of the Mohawk between Amsterdam and Little Falls, and in the Trenton and Birdseye limestone formations. Some of them have been idle for many years; others have furnished small quantities of stone for home use, and hence are only of local importance.

Canajoharie, Montgomery County.—There are three building-stone quarries opened in and near Canajoharie, and in the Calciferous formation, two of which are worked continuously. The openings are large, and there is much variation in the beds. The leading varieties are a bluestone and a gray, sub-crystalline stone, the latter of which is cut for monumental bases, sewer blocks, house trimmings and canal lock construction. A specimen of the gray variety from the quarry of A. E. Shaper was

* There is a fine cubical block from Mr. Shanahan's quarry in the State Museum collection whose polished face is almost jet black.

examined and gave an analysis 46.92 per cent. of lime, equivalent to 83.92 per cent. of calcium carbonate and 10.06 per cent. of insoluble matters. The specific gravity was 2.726 and the weight 169.9 pounds per cubic foot. Its absorptive capacity was found to be 0.07 per cent. The alternate freezing and thawing produced no change, but the high temperature calcined the specimen so that it fell to pieces in handling. The stone of these quarries can be seen in the churches of Canajoharie and Fort Plain, and in some of the large mill buildings of Utica.

**Palatine Bridge, Montgomery County.**— On the north or left bank of the Mohawk there are two large quarries which furnish blue and gray limestones for common wall work and for cut work. These quarries are in the same formation as those across the river in Canajoharie, and the stone resembles closely that of the latter quarries. In all of them the beds dip southerly 5° to 10°, and the stripping is comparatively light.

**At Fort Plain and St. Johnsville, Montgomery County,** the Birdseye limestone is opened in small quarries for local use.

**Little Falls, Herkimer County.** — There are three quarries in the Calciferous sandrock, in the bluff north of the town, which produce stone for common wall work for local use. The stone is fine-grained and of a bluish-gray shade of color, weathering to gray. Northwest of the town one and a half miles, there is a quarry on the Wilcox property and in the Trenton and Birdseye limestone. The stone is sold for curbing and flagging mainly.

**Newport, Herkimer County.** — In this town there are three quarries in the limestone, which furnish stone for local use, and for canal lock construction.

**Holland Patent, Oneida County.** — The quarries in the Trenton limestone at this place are of local importance only.

**Prospect, Oneida County.** — The cañon of the West Canada creek has exposed the Trenton limestone between this place and Trenton Falls, and made the upper beds easily accessible, and workable to advantage.

On the west side of the creek (Oneida County) Evan T. Thomas and H. & L. N. Jones have quarries; on the east side, in Herkimer county, there are two quarries, worked by Edward Callahan and

George & Griffith of Utica. The covering of soil and earth is light, and is thrown into the gorge with waste rock. The beds lie nearly horizontal and are thin so as to be cut to advantage for platforms, flagging-stone, lintels, sills and water-tables. The stone is carted to Prospect station, one and a half miles, and there shipped.

A representative specimen of the best stone from the quarry of Evan T. Thomas was found to have a specific gravity of 2.723 and a weight per cubic foot of 169.8 pounds. The percentage of lime 53.10 found, indicates 94.82 per cent. of calcium carbonate. The absorption percentage is 0.14. The freezing and thawing tests produced no apparent change; heating to 1200°–1400° F., and cooling suddenly made it a crumbling mass of lime.

The stone of these quarries is known as "Trenton gray limestone." It has been employed extensively in Utica, Rome, Norwich and other places. Examples of it are in the United States Government building, in St. John's Roman Catholic and in St. Paul's Lutheran churches in Utica; in the Roman Catholic churches at Little Falls and at Sandy Hill; and in the Methodist Episcopal church in Herkimer. Some of the stone is cut at Utica into monumental bases. The best cut stone is gray in color and sub-crystalline in texture.

It fades after long exposure to the atmosphere and loses its freshness of surface.

**Leyden, Lewis County.**—Blue limestone has been quarried near Talcottville, on Sugar river at Leyden station, and near Port Leyden. Much stone for canal lock construction has been obtained at some of the Leyden quarries.

**Lowville, Lewis County.**—L. H. Carter and Hiram Gowdy have quarries southeast of the village, and east of the R., W. & O. R. R. line. The geological horizon is that of the Trenton and Birds-eye limestones. The beds are nearly horizontal, and some of them are two to three feet thick. The heavy beds furnish stone for bridge abutments.

The Lowville stone is generally much darker in shade than the Prospect stone and looks well when fine-tooled. The principal market is Lowville and adjoining towns. Much of the stone has been used on the U. & B. R. branch in bridge abutments.

**Watertown, Jefferson County.**— The gray of the Trenton and the heavy beds of the Black river limestones are finely exposed to view in the gorge of the Black river at Watertown. They are not worked.

**Three Mile Bay, Jefferson County.**— At this place the limestone is so thinly covered as to be readily opened, and stone for local use is obtained in several small quarries. Barron's quarry is close to the lake shore, and half a mile from the railroad station.

The lower beds are worked into cut stone for house trimming and cemetery work. Watertown and the lake ports are the chief markets.

At **Brownsville** some limestone is quarried at the side of the Cape Vincent branch railroad for local use.

**Chaumont, Jefferson County.**—There are several large quarries at Chaumont, two of which, Adams Bros. and Duford & Sons, are run steadily. The former has a quarry face a mile in length. They are in the horizon of the Black river and Trenton limestones. The beds dip westward at a small angle and are divided into large blocks by vertical joints.

There is a blue limestone at the top which is made into lime, or used for common wall work. Under it is the gray sub-crystalline variety, in what are known as the 32-inch and the 16-inch beds, besides thinner beds lower down. The surface courses furnish stone for lime manufacture. The stone of the thicker beds is cut for lock facing and bridge work; the thin beds are worked into house trimmings. These quarries are on the shore of the bay, convenient to navigation and are near the railroad also. The product is increasing from year to year. Much of the Chaumont stone has been put into Erie canal locks.

The Protestant Episcopal Church, the County Clerk's office and City Opera House in Watertown are examples in construction.

Oswego, Fulton and Utica are other markets.

**Ogdensburg, St. Lawrence County.**— The number of stone buildings in Ogdensburg is comparatively large, and the material is almost all out of local quarries in the Chazy limestone formation.

The Town Hall and the St. John's Protestant Episcopal Church are beautiful examples of the stone which is found here. The quarry which is now worked for the local supply is on the Oswegatchie River, two miles south of the town.

**Norwood, St. Lawrence County.**— A blue limestone is quarried one and a half miles from Norwood on the O. & L. C. R. R. line. It can be seen in the Presbyterian churches at Malone, Waddington and Canton; the Roman Catholic church at Hogansburg, and in the county buildings at Canton.

**Schoharie, Schoharie County.**— Limestones of the Lower Helderberg and Water-lime groups crop out in the valley east of the village of Schoharie, and afford excellent building stone. The black, tentaculite limestone is very compact and takes a high polish. The use thus far is for the town only.

The Reformed Dutch Church and Revolutionary Stone Fort in the lower Schoharie valley, built in 1766, shows how well the limestone resists the weather.

**Howe's Cave, Schoharie County.**— Formerly a large amount of building stone was quarried here in the bluff above the hydraulic limestone beds. The latter only are now worked.

**Cobleskill, Schoharie County.**— William Reilly has two quarries near this place, one a half mile northwest of the village and the other about two miles to the northeast. Both are in the Upper Helderberg limestone.

Two principal kinds of stone are taken out — a hard bluestone and a gray, sub-crystalline variety, which is cut and dressed for dimension work. A specimen of the latter was examined and found to contain 53.86 per cent. of lime, or 96.18 per cent. of carbonate of lime, and 2.26 per cent. of matter insoluble in dilute hydrochloric acid. Its specific gravity was 2.713, equivalent to a weight of 169 pounds to the cubic foot. The absorption percentage was 0.109. Unaffected apparently by alternate freezing and thawing, it was calcined at a high heat (1200°–1400° F.).

The stone of this quarry has a home market; it is shipped to Binghamton, Oneonta, Cooperstown, Albany and other places on

the Albany and Susquehanna railroad. It was used in the German Methodist Episcopal church, Clinton and Alexander streets; in the Roman Catholic church, Central avenue, and in the Hawk street viaduct, Albany.

**Sharon Springs, Schoharie County.**— The Lower Helderberg limestones at Sharon Springs and its vicinity are opened at several points, and stone is obtained for local use in flagging, crosswalks and housework. The limestones of the Upper Helderberg epoch in their westward extension into Otsego county crop out in many ledges in the towns of **Cherry Valley** and **Springfield**, and afford good building stone for local use. The Presbyterian church and Belcher House, in the village of Cherry Valley; the Otsego County Jail, Fenimore House, and the house of Edward Clark in Cooperstown, are examples in construction of the stone from these quarries. In the town of **Stark**, in **Herkimer** county, a small quarry has been worked in the same gray limestone.

The Corniferous limestone was opened many years ago in small quarries at **Cassville**, **Waterville** and **Oriskany Falls**, in the southern part of Oneida county.

**Perryville, Madison County.**— Three quarries are worked at irregular times at this place. The stone is the Onondaga gray limestone and is used as there is a demand for it; mainly for bridge work.

In Onondaga county the Onondaga gray limestone is well developed and is quarried extensively. There are quarries at **Manlius**, **Jamesville**, on the **Onondaga Indian Reservation**, and at **Split Rock**.

**Onondaga Indian Reservation Quarries.**— This group of quarries is six and a half miles south of Syracuse and in the northeast corner of the reservation. There are five parties at work within a range of three-eighths of a mile from north to south. The dip of the beds is generally to the west-southwest, and at low angles.

The upper beds are blue limestone which is waste, excepting a small part which is used for rubble. The gray limestone has a crystalline texture, and a specific gravity of 2.708, equivalent to a weight of 168 pounds per cubic foot. It is dressed readily and

fine tooled surfaces are light gray, resembling the gray granites of Maine, and contrasting well with the rock-face stone which is so much darker colored. It is a strong and durable stone, as is proven in the old buildings in Syracuse and elsewhere. Specimens of fine cut gray limestone, which have been exposed to the weather forty-eight years in the old City Hall, exhibit no indication of decay, and no alteration other than a fading in color. One defect in the stone is the very thin, black, shaly seams which sometimes give it the appearance of checking; but there are no clay seams as in some of our limestones.

In quarrying it is not possible to get as thick beds as in the granites and some of the sandstones, two feet being the average thickness.

A representative specimen from Hughes Bros., of Syracuse, was found to contain 53.76 per cent of lime and 0.60 per cent of magnesia, or 96 per cent of carbonate of lime and 1.26 per cent of carbonate of magnesia. Matters insoluble in dilute acid were 1.52 per cent. The water absorbed was 0.14 per cent. The freezing and thawing tests did not produce any apparent change. Subjected to a temperature of 1200°–1400° F., the stone was fully calcined.

**Split Rock Quarries.** — This group is in the town of Onondaga, five to seven miles west of Syracuse, and in the north-facing escarpment of the Upper Helderberg rocks. The beds are thinly covered by earth, and one or two beds, at most, are worked. In this way a large area has been quarried over. A great deal of stone for the Erie canal construction was obtained from these quarries.*

The Onondaga gray limestone has been the principal building stone in Syracuse. Among the many fine structures in which it has been used for walls and trimmings, may be noted the following: United States Government building; new City Hall; Hall of Languages; Syracuse University; Onondaga County Savings Bank; St. Paul's Protestant Episcopal Church; St. Mary's Roman Catholic Church, and the May Memorial Church.

Oswego, Binghamton, Elmira and other cities and towns in the central part of the State are markets for the stone.

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* One of the first railroads in Central New York was constructed from the Split Rock quarries to the canal, one mile west of Syracuse. — H. W. CLARKE.

**Union Springs, Cayuga County.**—The Onondaga limestone is opened in a group of quarries at Hamburg, one mile south of Union Springs, and on Daniel Mosher's farm, east of the village. A remarkable feature is the persistence of the quarry beds and their uniformity in the several quarries. The glacial drift on the limestone is from one to ten feet thick; the upper beds (or tiers, as here known) are blue limestone, and from two to twenty-four inches thick; the lower beds are generally thick and of a gray, sub crystalline stone. The thin beds answer for flagging; the heavier beds are worked into dimension blocks for building, canal lock and bridge pier construction. The markets are reached by boats on line of Erie canal.

The **Hamburg** quarries were opened more than sixty years ago, and the old grist-mill, the Chase House and the Howland House, show how well the stone has stood for that length of time.

**Auburn, Cayuga County.**— The Upper Helderberg limestone ledges at Auburn have afforded a good building stone; and a comparatively large percentage of stone buildings in that city are evidence of its enduring property. The Garrett Stone and Coal Company,* L. S. Goodrich & Son, and John Bennett & Son have quarries here. The first named was opened in 1810. The blue limestone of the upper beds is used for rubble-work only. The gray limestone occurring in "tiers" of from six inches to two feet thick, is cut for house trimmings, platforms, curbing and gutter-stones. It is dressed readily, and is of a light-gray color when fine cut; the rock face is dark colored.

It has been used in six beautiful churches; in the City Hall; in the Auburn Theological Seminary buildings; in the State arsenal and State prison, besides many stores and other structures in the city.

The principal outside markets have been Sayre, Pa., Owego, Elmira, Oswego, Geneva, Canandaigua, Newark Valley and Palmyra.

The Corniferous or Upper Helderberg group of limestone, including as the upper part the Corniferous or Seneca limestone,

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* Quarry not now in operation.

is well represented in a belt crossing the towns of Seneca Falls and Waterloo, and quarries are opened in both towns, for local use mainly.

The Waterloo quarries are large, and kept in operation almost all of the year. That of Loren Thomas, a half mile south of the town, has been worked for more than sixty years. Remarkably regular systems of vertical joints, at uniform distances apart, divide the stone into large, rectangular blocks, and facilitate the quarrying.

The beds are from seven to twenty-six inches thick, and fourteen to sixteen in number. The stone of these quarries resembles that of the formation to the east, in Cayuga and Onondaga counties.

The same geological formation appears in Ontario county, and there are small quarries in the towns of Canandaigua and Victor, which do a local business.

Going west the outcrops of the rocks of this geological epoch have been opened in small quarries in Mendon, Monroe County; near Caledonia, in Livingston County; and in LeRoy, Genesee County. There are two quarries at the latter place. They produce stone for common wall work. Some of the limestone found north of the town is said to dress well, and to be capable of receiving a good polish.

Williamsville, Erie County.— Several quarries have been opened at Williamsville, ten miles northeast of Buffalo. J. S. & F. H. Young and D. R. & H. Fogelsonger work quarries for building stone, mainly, for the Buffalo market. They are small, and not deep, as the rock is near the surface. The stone is light-gray, fine-crystalline, and dresses well.

It has a specific gravity of 2.708 and weighs 168 pounds per cubic foot. It contains 93.44 per cent. of calcium carbonate, and 3.82 per cent. of insoluble matter in dilute hydrochloric acid. Its absorption percentage is 0.16. It resisted freezing and thawing tests without apparent change, but was calcined at a temperature of 1200°–1400° F. It is used in Buffalo for cut stone trimmings. The quarries are six miles from the New York Central railroad line, but nearly all the stone is carted by teams to Buffalo.

**Buffalo.**— The Corniferous limestone and the Onondaga limestone are quarried extensively in this city for all common wall work.

The Buffalo Cement Company's quarry is the northernmost. South of it is the Yamarthal group of quarries. The drift-earth is thin, covering the quarry beds to a depth of one to four feet, as opened thus far. The limestone is in courses, lying horizontal, and from nine inches to two and a half feet thick. The stone is dark-colored, hard, compact and strong, and is well liked for walls and foundations. It is delivered in wagon loads, in the city, at six dollars per cord.

**Black Rock, Erie County.**—The Corniferous limestone at this place was formerly quarried for canal construction.

### Niagara Limestone.

**Rochester.**—Nearly all of the common building stone used in Rochester is obtained from quarries in the northeastern and in the western quarters of the city. A very small part of the best gray stone is used for rock-face ashlar work. The business is entirely limited to the city.

**Lockport, Niagara County.**—The Whitmore and Carpenter quarries are on the Erie canal, in the southwestern part of the town. The upper layers of stone are thin, but are succeeded by thick beds, to a depth of twelve to twenty-four feet. The dip is southward at a low angle. The stone is known as the Lockport gray limestone. It is light-gray, in places variegated with red; dense, solid and made up of comminuted crinoidal stems and coralline masses. The fine-cut surface does not differ greatly in shade of color from that of the rock-faced stone. These quarries were opened when the Erie canal was dug, in 1825, and the Carpenters began work here in 1829. The production has diminished greatly, owing to the general use of sandstones.

It has been used in Lockport for common wall work; for house trimmings and monumental uses it has had a wide market. The various buildings in the town show how well it has withstood the action of the weather for years.

The Lenox Library building, Fifth avenue and Seventieth to Seventy-first streets, New York, is an example of its use, but one

in which the stone shows crevices and holes, due to unequal weathering of coralline masses and of the more fossiliferous portion. The improper position of the stone in the walls (more than 40 per cent. being set on edge) may explain the serious defects seen in this example.

West of Lockport the Niagara limestone is quarried at Niagara Falls, for building in the town. Across the river, on the Canadian side, the same formation near Queenstown, furnishes some stone to Buffalo which is in much favor with some architects and builders.

## Road Metal.

By Heinrich Ries; Revised by F. J. H. Merrill.

The rocks used for road metal in New York State are diabase (trap.), granite, gneiss, limestone, sandstone, shale and gravel.

Many of the local stone quarries, which are scattered over the State, sell for road metal the rock obtained in stripping off the upper layers from their quarries.

There are a few large quarries which are operated for obtaining road metal alone and which deserve special mention.

Many tons of material are quarried annually from the Palisades range near Piermont. The material, which is exceedingly tough, is either dressed for paving blocks or crushed for road metal.

Farther up the Hudson river the limestone quarries of Tomkins Cove have been in operation for a number of years and supply large quantities of rock for macadam. It is one of the best materials used. This magnesian limestone is hard and packs easily and makes a good surface, but the cost of maintenance is considerable.

The following is an analysis of the Tomkins Cove Rock:

| | |
|---|---|
| Lime | 60.20 |
| Alumina | 11.22 |
| Silica | 6.13 |
| Magnesia | 10.45 |
| Carbonic acid | 8. |
| Water | 4. |
| | 100. |

At Iona Island a granite is quarried and crushed to five or six different sizes for road metal and concrete. The fine residue or dust is sold for polishing.

The Hudson River Stone Supply Company has an extensive plant for quarrying and crushing granite, at Breakneck Mt., north of Cold Spring. The same company operates a second plant for supplying crushed limestone at Stoneco, north of New Hamburg.

One of the largest quarries in the State is that of P. Callanan at South Bethlehem, Albany county. The Lower Helderberg limestone is the rock used and it makes a good road.

The Cauda Galli Grit of Albany county is used in small quantities locally and makes an excellent road, though it is not very durable.

At Duanesburg, near Schenectady, sandstone of the Hudson River group is crushed for road metal.

At Port Chester, Westchester county, a coarse-grained granite is quarried and is considerably used locally, but the best macadam roads of that district are of limestone from Tomkins Cove.

The gray gneiss has been considerably used as a road material in Westchester county.

On Staten Island the yellow gravel is much used for road making; also the diabase or trap from the Graniteville quarries, which is being extensively used on a system of county roads with the most satisfactory results.

The materials used for making roads in the State vary with the locality. If the traffic on the road is moderate it is generally safe to use the local material, whatever its nature, unless it be shale, but if there is a heavy traffic it will pay in most instances to get a stone of superior quality from elsewhere.

The requisite qualities of a road metal are hardness and toughness. Where both these qualities are not obtainable in the same stone the latter is perhaps preferable.

Igneous and silicious rocks, though often hard, do not consolidate as well nor so quickly as limestone, owing to the sandy detritus formed by the first two having no cohesion. The detritus of magnesian limestone acts like a mortar.

The most efficient and economical road metals are diabase or trap and syenite.

Granite and gneiss, especially if very micaceous, are apt to disintegrate rapidly and produce dust and mud.

Shale is to be avoided, as it breaks up rapidly, forming a sticky mud.

Gravel, while making a serviceable road, will not pack well, and is not durable. If it has to be used, some of the difficulty may be overcome by cracking half of the pebbles.

# DIRECTORY OF QUARRYMEN PRODUCING STONE FOR BUILDING PURPOSES.

By FREDERICK J. H. MERRILL.

* Parties producing in 1894. † Parties producing previous to 1894, now idle.

Parties not marked with asterisk or dagger have not recently been heard from. Where there is uncertainty as to the name of the quarry owner, it is omitted.

N. B.—The localities mentioned in the preceding text are generally the names of the nearest railway stations to the quarries. In the directory the town is the political division in which the quarry is located and its name may differ from that of the railroad station.

## GRANITE.

| Post-office. | NAME. | Location of Quarry. | |
|---|---|---|---|
| | | Town. | County. |
| Cold Spring | Bailey, James E.* | Phillipstown | Putnam. |
| " | Bailey, Lewis J | " | " |
| Garrison | King Granite Co.* | " | " |
| Keeseville | Ausable Granite Co. (B. B. Mason agent) | Chesterfield | Essex. |
| Mechanics and Traders' Exch., New York | Donovan, Daniel E.* | Round Island, town of Stony Point | Rockland. |
| 187 West street, New York | Van Wagner & Duff* | Piermont | " |
| Montreal | International Granite Co | Clayton | Jefferson. |
| Montreal | Thousand Island Granite Co.* | Grindstone Island, town of Clayton | " |
| Peekskill | Hudson River Granite Co | Cortland | Westchester. |
| Port Chester | Rich, G. H | Rye | " |
| Port Richmond | Bennett, Frank & Co | Northfield | Richmond. |
| Sufferns | | Ramapo | Rockland. |
| Thurso | Chicago Granite Co | Clayton | Jefferson. |

DIRECTORY OF QUARRYMEN PRODUCING STONE FOR BUILDING PURPOSES — SANDSTONE — (*Continued*).

| Post-office. | NAME. | LOCATION OF QUARRY. | |
|---|---|---|---|
| | | Town. | County. |
| Thurso | Gordon & Turcotte | Clayton | Jefferson. |
| Westport | Lake Champlain Granite Co | Westport | Essex. |
| | GNEISS (GRANITE). | | |
| Croton Falls | Ganung, Edwin C.† | Carmel | Putnam. |
| Hartsdale | Hitchcock, Welcome G.* | Hartsdale | Westchester. |
| Hastings | Lefurgy, William G | Greenburg | " |
| Kensico | | North Castle | " |
| Little Falls | Brady, A. N | Little Falls | Herkimer. |
| " | McGoup, John | " | " |
| Scarsdale | Seely, Henry S.† | Greenburg | Westchester. |
| Tarrytown | Sackett, Stephen J | " | " |
| West Point | | Cornwall | Orange. |
| Wilton | Jennings, Mrs | Wilton | Saratoga. |
| Yonkers | Valentine, Mr | Yonkers | Westchester. |
| | SANDSTONE. | | |
| Albany | Fuller, Wm. & Sons* | New Baltimore | Greene. |
| Albion | Albion Stone Co.* | Barre | Orleans. |
| " | De Graaf & Roberts* | " | " |
| " | Garrett & Atkinson* | " | " |
| " | Goodrich & Clark Stone Co | " | " |
| Belfast | Lang, James† | Belfast | Allegany. |

| | | | |
|---|---|---|---|
| Belmont | Johnson, James | Amity | " |
| Belvidere | Dibble, Albert | " | " |
| Brockport | Coon, George | Sweden | Monroe. |
| Camden | | Camden | Oneida. |
| Canajoharie | Shaper, A. E | Canajoharie | Montgomery. |
| Clayton | Wilber, S. H.* | Clayton | Jefferson. |
| Clinton | Dawes, Charles* | Kirkland | Oneida. |
| " | McCabe, John | " | " |
| " | Moore, Richard | " | " |
| Clymer | | Clymer | Chautauqua. |
| Cooperstown | Wood, John* | Middlefield | Otsego. |
| Corning | Bedient, James H | Corning | Steuben. |
| " | Kelley, John | " | " |
| Coventry | F. G. Clarke & Sons | Coventry | Chenango. |
| Cuba | | Cuba | Allegany. |
| Dansville | Schubinehl, Martin J.* | Dansville | Livingston. |
| Dormansville | Stewart, Wm | Westerlo | Albany. |
| East Guilford | Mullen & Miller* | Guilford | Chenango. |
| Elmira | Symonds, A. D | Elmira | Chemung. |
| Fort Ann | Holmes, Andrew D.* | Fort Ann | Washington. |
| " | Parrish, Franklin | " | " |
| " | White, Jenkins | " | " |
| Fort Jackson | Downey Bros.† | Hopkinton | St. Lawrence. |
| Frankfort | Joslin, M. T.† | Frankfort | Herkimer. |
| Frankfort Hill | | " | " |
| Fulton | Granby Brownstone Co.* | Granby | Oswego. |
| " | Jennings, Orvill J.* | Volney | " |
| Goodyears | Barger, J. G.* | Genoa | Cayuga. |
| Grand View | Brown, William H.* | Orangetown | Rockland. |
| Hammond | Finnegan, Mr | Hammond | St. Lawrence. |
| " | Foster, H. A | " | " |

DIRECTORY OF QUARRYMEN PRODUCING STONE FOR BUILDING PURPOSES — SANDSTONE — (*Continued*).

| Post-office. | NAME. | LOCATION OF QUARRY. | |
|---|---|---|---|
| | | Town. | County. |
| Hammond | Parmeter, D. E | Hammond | St. Lawrence. |
| " | Stanley, W. H | " | " |
| Haverstraw | Demarest, P. E.† | Haverstraw | Rockland. |
| Higginsville | | Verona | Oneida. |
| Highland | Clearwater, F. S | Lloyd | Ulster. |
| Himrods | Cheney, Louis A.* | Himrods | Yates. |
| Hindsburg | Baldwin & Hinds* | Murray | Orleans. |
| " | Burns, L. G.* | " | " |
| " | Chadwick Bros.* | Albion | " |
| " | Chadwick, Thomas, Jr.* | Murray | " |
| Holley | Downs & Bowman* | Clarendon | " |
| " | O'Brien & Co | Murray | " |
| Hornellsville | Cobb, J. F | Hornellsville | Steuben. |
| Hulburton | Cornwell, Lafayette | Murray | Orleans. |
| " | Fancher, Edward* | " | " |
| " | Ford, A. H.* | " | " |
| " | Gwynne, C. F. | " | " |
| " | Hamilton, Charles J.* | " | " |
| " | Hebner, Jno | " | " |
| " | Lardner, Thomas | " | " |
| " | Newsome, William* | Barre | " |
| " | Phillips, Marcus* | Murray | " |
| " | Squire, A. J | " | " |

| | | | |
|---|---|---|---|
| " | Sturaker & Sullivan | " | " |
| " | Von York, Constantin * | " | " |
| Ithaca | McClune, G. C.† | Ithaca | Tompkins. |
| Jamestown | McVeigh, John | Ellicott | Chautauqua. |
| Keeseville | Hoag, Richard† | Chesterfield | Essex. |
| Kingston | | Kingston | Ulster. |
| Kirkland | | Kirkland | Oneida. |
| Kiskaton | | Catskill | Greene. |
| Leeds | | " | " |
| Lewiston | Hotchkiss, L. W.* | Lewiston | Niagara. |
| Little Falls | Casey, John* | Manheim | Herkimer. |
| Lockport | Spalding, William* | Lockport | Niagara. |
| " | Stanthorpe, C. N. & Co. | " | " |
| " | Whitmore, Charles† | " | " |
| Malden | Ulster Bluestone Co.* | Malden | Ulster. |
| Malone | Bashaw, Peter* | Malone | Franklin. |
| " | Morris, Antoni | " | " |
| " | Paddock, S. A | " | " |
| Medina | Garrett, Thos | | |
| " | Gorman, Chas. A.*. | Murr'y, Barre & Rdgw'y | Orleans. |
| " | Gorman & Stork* | Barre | " |
| " | Gotts & Stork * | " | " |
| " | Horan, Patrick | Ridgeway | " |
| " | Horan, Mrs. S. J. | " | " |
| " | Kearney & Barrett | " | " |
| " | McCormick, A. J | " | " |
| " | Mooney Bros | " | " |
| " | Noble & Lyle | " | " |
| " | O'Reilly, Bernard* | Murray | " |
| " | Scanlon, Martin* | Barre | " |
| " | Slack, Michael* | Holley | " |

DIRECTORY OF QUARRYMEN PRODUCING STONE FOR BUILDING PURPOSES — SANDSTONE — (*Continued*).

| Post-office. | NAME. | LOCATION OF QUARRY. | |
|---|---|---|---|
| | | Town. | County. |
| Medina | Stark, Jos | Ridgeway | Orleans. |
| " | Wall, Wm. H., sup't Holloway quarries* | " | " |
| Middleburg | Bishop, Amberson† | Middleburg | Schoharie. |
| Monroe | | Monroe | Orange. |
| New Baltimore | Matthews, Andrew† | New Baltimore | Greene. |
| " | Smith & McCabe | " | " |
| New Hartford | | New Hartford | Oneida. |
| New Hudson | Searle, Mr | New Hudson | Allegany. |
| North Cohocton | Whitney, Theo.* | Cohocton | Steuben. |
| Nyack | Puff, Nelson | Orangetown | Rockland. |
| " | Smith, Dan. F | " | " |
| Olean | Olean Bluestone Co.* | Olean | Cattaraugus. |
| Olive | Bogart, E. H.* | Olive | Ulster. |
| Oneonta | | Oneonta | Otsego. |
| Oswego Falls | Faulkner, James | Granby | Oswego. |
| Oxford | Clarke, F. G. & Son* | Oxford | Chenango. |
| " | Walker, D. & Son | " | " |
| Palenville | | Catskill | Greene. |
| Panama | | Harmony | Chautauqua. |
| Penfield | | Penfield | Monroe. |
| Penn Yan | Cornwell, Geo. R.† | Milo | Yates. |
| Portageville | Genesee Valley Bluestone Co.* | Genesee Falls | Wyoming. |
| Port Henry | Bond, L. W.* | Moriah | Essex. |
| Potsdam | Clarkson, A. (Secretary) | Potsdam | St. Lawrence. |

| | | | |
|---|---|---|---|
| " | Potsdam Red Sandstone Co | " | " |
| Rexford Flats | Benedict, Levi† | Niskayuna | Schenectady. |
| Rochester | Brady, Gilbert* | Albion | Orleans. |
| Rockville | Searle, Abram | Belfast | Allegany. |
| Rome | | Rome | Oneida. |
| Saugerties | Burhans & Brainard* | Saugerties | Ulster. |
| Schenectady | Shear, Albert & Co | Niskayuna and Duanesburg | Schenectady. |
| " | Smith, Levi | Niskayuna | " |
| Shelby Basin | Le Valley, John * | Ridgeway | Orleans. |
| Smithville Flats | | Smithville | Chenango. |
| South Berne | Bailey, David | Westerlo | Albany. |
| South Hammond | Stanley, W. H | Hammond | St. Lawrence. |
| Troy | | Troy | Rensselaer. |
| Trumansburg | Biggs, D. S. & Sons* | Ulysses | Tompkins. |
| Utica | Conley, F. E.* | Verona | Oneida. |
| Verona | | " | " |
| Warsaw | Warsaw Bluestone Co | Gainesville | Wyoming. |
| Washington Mills | Griffiths, Wm.* | New Hartford | Oneida. |
| " | Mallory, J. P | " | " |
| " | Thompson, E. F.† | " | " |
| " | Trimbey, H. J.* | " | " |
| Watkins | Higgins, D. H | Reading | Schuyler. |
| Watts Flats | Gould, Fred. H.* | Harmony | Chautauqua. |
| Waverly | Boget, M. L.* | Barton | Tioga. |
| " | Fleckenstine, J. W | ? | " |
| " | Murray, John H. | " | " |
| Westfield | | Westfield | Chautauqua. |
| Whitehall. | McLaughlin, John | Whitehall | Washington. |
| Wolcott | | Wolcott | Wayne. |

# HUDSON RIVER BLUESTONE.

H. B.: Sell to Hewitt Boice.
J. N. & Sons: Sell to James Nevins & Sons.
K. Bros.: Sell to Kirkpatrick Bros.
M. & R.: Sell to Many & Ross
R. & T.: Sell to Roger & Tappen.
U. B. S. Co.: Sell to Uls'er Bluestone Co.
W. E. S.: Sell to W. E. Scott.

| Post-office. | NAME. | Location of Quarry. | |
|---|---|---|---|
| | | Town. | County. |
| **Albany County.** | | | |
| Reidsville | Brate, Chas | Berne | Albany |
| **Chenango County.** | | | |
| Oxford | Clarke, F. G., Bluestone Co | Oxford | Chenango |
| " | Walker, Melvin | " | " |
| Tyner | Loomis, Perry* | Smithville | " |
| **Delaware County.** | | | |
| Fish's Eddy | Martin, George. *K. BROS.* | Denning | Ulster |
| " | McGreib, William. " | " | " |
| " | Prothra, D. L. " | " | " |
| " | Robinson, John. " | " | " |
| " | Steib Brothers. " | " | " |
| Hale's Eddy | Bagle & Labdell. " | Tompkins | Delaware. |
| " | Cole, Fred. " | " | " |
| " | Desselberger, A. " | " | " |
| " | Doolittle, J. E. " | " | " |
| " | Griffin, Pat. " | " | " |
| " | Kennedy Brothers. " | " | " |
| " | Kingsbury, O. M., & Co. *W. E. S.* | " | " |
| " | Mazo & Beagle. *K. BROS.* | " | " |

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|---|---|---|---|---|---|
| " | ..... | Page, John J. | " ..... | " ..... | " |
| " | ..... | Palmatier & Beagle. | " ..... | " ..... | " |
| " | ..... | Thomas, E. E. | " ..... | " ..... | " |
| Hamden | ..... | Kenny, James. | *J. N. & SONS*..... | Hamden ..... | " |
| " | ..... | Merritt, J. | " ..... | " ..... | " |
| Hancock | ..... | Carner, George. | *K. BROS*..... | Hancock ..... | " |
| " | ..... | Christian, Byron | " ..... | " ..... | " |
| " | ..... | Cotter Brothers. | " ..... | " ..... | " |
| " | ..... | Kazenstein, George W. | " ..... | " ..... | " |
| " | ..... | Keery, Thomas, Jr. | " ..... | " ..... | " |
| " | ..... | Keery & Weiman. | " ..... | " ..... | " |
| " | ..... | Kirkpatrick Brothers. | " ..... | " ..... | " |
| " | ..... | Schaffer Brothers | " ..... | " ..... | " |
| Lordville | ..... | Adams, Jerry. | " ..... | " ..... | " |
| " | ..... | Chambers & Van Duzer. | " ..... | " ..... | " |
| " | ..... | Curry, John. | " ..... | " ..... | " |
| " | ..... | Denio, L. | " ..... | " ..... | " |
| " | ..... | Fisher, John. | " ..... | " ..... | " |
| " | ..... | Flemming, James. | " ..... | " ..... | " |
| " | ..... | Hinaman, T. | " ..... | " ..... | " |
| " | ..... | Holbert, F. R. | " ..... | " ..... | " |
| " | ..... | Lord, Jacob & Son. | " ..... | " ..... | " |
| " | ..... | Maich, B. & Co. | " ..... | " ..... | " |
| " | ..... | Roloson, A. J. | " ..... | " ..... | " |
| " | ..... | Roloson, F. L. | " ..... | " ..... | " |
| " | ..... | Smith, Frank. | " ..... | " ..... | " |
| Peakville | ..... | Kniffer, D ..... | | " ..... | " |
| " | ..... | Merritt, Bros ..... | | " ..... | " |
| " | ..... | Pothero, D. H ..... | | " ..... | " |
| " | ..... | Pothero & Clark..... | | " ..... | " |
| " | ..... | Ressman, F. W .. ..... | | " ..... | " |

## Hudson River Bluestone — Delaware County — (*Continued*).

| Post-office. | NAME. | Location of Quarry. | |
|---|---|---|---|
| | | Town. | County. |
| Peakville | Skinner & Buckley | Hancock | Delaware. |
| " | Staib Bros | " | " |
| " | Staib & Biffas | " | " |
| " | Upham, Geo | " | " |
| Rock Rift | Huntington, E | Tompkins | " |
| Stockport Station | Fitzpatrick & Burns. *K. BROS.* | Hancock | " |
| " | Lakin, Edgar " | " | " |
| " | Morse, J. & Co. " | " | " |
| " | Watson, L. " | " | " |
| Walton | Babcock & Morgan. *J. N. & SONS* | Walton | " |
| " | Babcock & Storie. *K. BROS.* | " | " |
| " | Cash, J. *J. N. & SONS* | " | " |
| " | Davis, Joseph. *K. BROS.* | " | " |
| " | Dunn, H. *J. N. & SONS.* | " | " |
| " | France & Bushnell. " | " | " |
| " | Gray & Marvin.* *J. N. & SONS AND K. BROS.* | " | " |
| " | Merriott, John. *K. BROS.* | " | " |
| " | Nevins, James & Sons. | " | " |
| " | Robinson, Geo. C. *K. BROS.* | " | " |
| " | Sheppard & Baxter. " | " | " |
| " | St. John, H. E. " | " | " |
| " | Terry & Robinson. *K BROS AND J. N. & SONS* | " | " |

| | | | | |
|---|---|---|---|---|
| " | Wakeman, Ezra. | *K. BROS.* | " | " |
| " | Warner, G. T. | *W. E. S* | " | " |

GREENE COUNTY.

| | | | | |
|---|---|---|---|---|
| Palenville | Cook, Asa & Co. | *U. B. S. CO.* | Catskill | Greene |
| " | Dolan, John. | " | " | " |
| " | Hommel, Edward | " | " | " |
| " | Hungerford, Anthony. | " | " | " |
| " | Lamoree, Frank & Co. | " | " | " |
| " | Lasher, Fred. | " | " | " |
| " | Newkirk, Isaac. | " | " | " |
| " | Post, E & Co. | " | " | " |
| " | Stone, Sylvester. | " | " | " |
| " | Winne, James A. | " | " | " |
| " | Woloen, John H. | " | " | " |

SCHOHARIE COUNTY.

| | | | | |
|---|---|---|---|---|
| Hunter's Land | Lampman, Robert H † | | Berne | Albany. |

SULLIVAN COUNTY.

| | | | | |
|---|---|---|---|---|
| Callicoon | Benadim Bro. | *M. & R* | Callicoon | Sullivan. |
| " | Lenihaus, A.* | " | " | " |
| " | Persbacker, Bros. | *K. BROS.* | " | " |
| " | Schmidt, N. | *M. & R* | " | " |
| " | Werlaw, John. | " | " | " |
| Callicoon Depot | Dering, John.* | " | " | " |
| " | Tyler, I. | " | " | " |
| " | Tyler & Dering. | " | " | " |
| Hankins | Bogart, I. | " | Fremont | " |
| " | Bohn Brothers. | " | " | " |
| " | Brustman, John. | " | " | " |
| " | Clark, Michael. | " | " | " |

HUDSON RIVER BLUESTONE — SULLIVAN COUNTY — (*Continued*).

| Post-office. | NAME. | | Location of Quarry. | |
|---|---|---|---|---|
| | | | Town. | County. |
| Hankins | Conroy, James & Co. | *M. & R.* | Fremont | Sullivan. |
| " | Decker, I. | " | " | " |
| " | Henderson Bros. | " | " | " |
| " | Homer, George. | " | " | " |
| " | Kelley, John. | " | " | " |
| " | Lacey & Crawfield. | " | " | " |
| " | Manny & Ross | | " | " |
| " | Mounty, P. & Sons. | *M. & R.* | " | " |
| Long Eddy | Bellows & Ryan. | " | " | " |
| " | Carrick Bros. | *K. BROS.* | " | " |
| " | Cuddie, J | | " | " |
| " | Curran, J. | *K. BROS.* | " | " |
| " | Dunn & Co. | " | " | " |
| " | Fritz, Fred. | *M. & R* | " | " |
| " | Fritz, I | | " | " |
| " | Hanstine, H. | *M. & R* | " | " |
| " | Hanstine, J | | " | " |
| " | Hughes & Co. | *K. BROS.* | " | " |
| " | Hughes & Sperback. | *M. & R.* | " | " |
| " | Jenson, A. M. | " | " | " |
| " | Jenson, H | | " | " |
| " | Kern, John.* | *M. & R* | Hancock | Delaware. |
| " | Kellam, B | | " | " |

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|---|---|---|---|
| " | Kellam, Wm. M. *M. & R.* | " | " |
| " | Kenney Bros. *W. E. S* | " | " |
| " | Miller, I | " | " |
| " | Miller, J. C. *M. & R* | Fremont | Sullivan. |
| " | Myers, C & Co. *K. BROS.* | " | " |
| " | Peak, Cyrus.* *M & R* | Hancock | Delaware. |
| " | Peak, Henry. " | " | " |
| " | Peak, William. *M. & R. & K. BROS.* | " | " |
| " | Rose, J. *M. & R* | " | " |
| " | Schuman, J. F. " | " | " |
| Narrowsburg | Engelman, Geo. W. *W. E. S* | Tusten | Sullivan. |
| Port Jervis | Terbell & Ridgeway | Forestburg | " |
| Rockland | Signor, Wm. & Son | Rockland | " |
| Roscoe | Baker & Stickle | " | " |
| " | Conner, H. C. *K. BROS* | " | " |
| " | Craft, Israel* | " | " |
| " | Gregg & Miller* | " | " |
| " | Kline, C | " | " |
| " | Sherwood & Stewart * | " | " |
| " | Supton & Tiffany * | " | " |
| " | Tiffany, R. H | " | " |
| " | Tindden, Jas | " | " |
| " | Youman, Wm. | " | " |

ULSTER COUNTY.

| | | | | | |
|---|---|---|---|---|---|
| Allaben | McGregor, S. | *H. B* | Shandaken | Ulster. |
| Brodhead | Bishop, E. | " | Olive | " |
| " | Bishop, M. | " | " | " |
| " | Cornish, W. | " | " | " |
| " | Grambell, James | " | " | " |

HUDSON RIVER BLUESTONE — ULSTER COUNTY — (*Continued*).

| Post office. | NAME. | | Location of Quarry. | |
|---|---|---|---|---|
| | | | Town. | County. |
| Brodhead | Hungerford, Alonzo. | *H. B.* | Olive | Ulster |
| " | Lyons, L. | " | " | " |
| " | Winn, Marshall | " | " | " |
| Glenford | Ballard, Sherman. | *R. & T.* | " | " |
| " | Brower, Edward. | " | " | " |
| " | Burlin, Wm. | " | " | " |
| " | Burton, H. | " | " | " |
| " | Castle, Wm. | " | " | " |
| " | Hicks & Cudney. | " | " | " |
| " | Hyatt, Clancy. | " | " | " |
| " | Johnson, Henry. | " | " | " |
| " | Krom, Wm. | " | " | " |
| " | Krum, Walter. | " | " | " |
| " | Lasher, Chas. | " | " | " |
| " | Martin, David. | " | " | " |
| " | Moore, John. | " | " | " |
| " | North, B. | " | " | " |
| " | Phillips, Rudolph. | " | " | " |
| " | Russell, John | " | " | " |
| " | Vallely, W. H. | " | " | " |
| " | Winnie, C. | " | " | " |
| " | Winters, Peter. | " | " | " |
| Hurley | Ostrander, Samuel. | *H. B.* | Hurley | " |

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|---|---|---|---|
| Kingston | Beekman, Thomas. | " | Kingston |
| " | Britt, Deyo. | " | " |
| " | Burk, Bernard. | " | " |
| " | Thompson, Richard. | " | " |
| Lomontville | Bonkyonk, John. | " | Marbletown |
| " | Broadhead, L. | " | " |
| " | Broadhead, Wm. | " | " |
| " | Clearwater, James. | " | " |
| " | Clearwater, John. | " | " |
| " | Degraff, Charles. | " | " |
| " | Degraff, Edward. | " | " |
| " | Degraff, John H. | " | " |
| " | Degraff, John J. | " | " |
| " | Degraff, Matthew. | " | " |
| " | Degraff, Wm. | " | " |
| " | Dewitt, Jacob. | " | " |
| " | Dewitt, Wm | " | " |
| " | Duffy, Peter. | " | " |
| " | Dunn, John | " | " |
| " | Dunn, Patrick. | " | " |
| " | Elliott, Robert. | " | " |
| " | Emrich, Leir. | " | " |
| " | Guinna, E. | " | " |
| " | Gutches, William. | " | " |
| " | Johnson, Garret. | " | " |
| " | Jones, Spencer. | " | " |
| " | Mack, James. | " | " |
| " | Mack, Patrick. | " | " |
| " | Miller, Henry. | " | " |
| " | Pratt, Charles. | " | " |
| " | Robinson, Lewis. | " | " |

HUDSON RIVER BLUESTONE — ULSTER COUNTY — (*Continued*).

| Post-office. | NAME. | | LOCATION OF QUARRY. | |
|---|---|---|---|---|
| | | | Town. | County. |
| Lomontville | Rose, Andrew. | *H. B.* | Marbletown | Ulster. |
| " | Sampson, A. | " | " | " |
| " | Sampson, John. | " | " | " |
| " | Sampson, Samuel D. | " | " | " |
| " | Sampson, Thomas. | " | " | " |
| " | Sampson, Thomas N. | " | " | " |
| " | Sampson, William. | " | " | " |
| " | Schryver, Edward. | " | " | " |
| " | Schryver, Isaac. | " | " | " |
| " | Terwilliger, T. | " | " | " |
| " | West, Norman. | " | " | " |
| " | Winchell, F. | " | " | " |
| " | Winchell, Jno. | " | " | " |
| " | Winchell, Jno. J. | " | " | " |
| Marbletown | Bush, T. H. | *R. & T.* | " | " |
| " | Clearwater, Jacob. | " | " | " |
| " | Elliott, Robt. | " | " | " |
| " | Eunist, Levi. | " | " | " |
| " | Goutcheus, Wm. | " | " | " |
| " | DeGraff, Wm. | " | " | " |
| " | Jones, Squire. | " | " | " |
| " | Mack, Patrick. | " | " | " |
| " | Miller, Henry. | " | " | " |

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|---|---|---|---|
| " | Sampson Samuel. | " | " |
| " | Smith, Chas. | *H. B* | " |
| " | Terwillegher, C | " | " |
| " | West, Norman. | " | " |
| " | Winchell, John J. | " | " |
| Mount Pleasant | Eighmey, I. B. | " | Shandaken | " |
| Olive | Chase, Charles. | " | Olive | " |
| " | Flower, A. | " | " | " |
| " | Flower, Wm. | " | " | " |
| " | Hogan, George. | " | " | " |
| " | Hogan, Luke. | " | " | " |
| " | Hughes, George. | " | " | " |
| " | Hughes, Oliver. | " | " | " |
| " | Pearson, Sidney. | " | " | " |
| " | Phillips, C. | " | " | " |
| " | Phillips, Frank. | " | " | " |
| " | Phillips, R. & Co. | " | " | " |
| Phœnicia | McGrath, John L. | " | Shandaken | " |
| " | Simpson, A. J. | " | " | " |
| Plattekill | Althiser, E. | " | Plattekill | " |
| " | Federkill, John. | " | " | " |
| " | Feter, Elijah. | " | " | " |
| " | Fratzer, F | " | " | " |
| " | Gallager, Philip. | " | " | " |
| " | Hart, Charles. | " | " | " |
| " | Hart, Henry. | " | " | " |
| " | Hickory, John. | " | " | " |
| " | Hiller, C. | " | " | " |
| " | Hollelight, A. | " | " | " |
| " | Lediger, Henry. | " | " | " |
| " | Longendyke & Co. | " | " | " |

## Hudson River Bluestone — Ulster County — (*Continued*).

| Post-office. | NAME. | | Location of Quarry. | |
|---|---|---|---|---|
| | | | Town. | County. |
| Plattekill | Low, Wesley. | *H. B* | Plattekill | Ulster. |
| " | Mehem, F. L. | " | " | " |
| " | Riece, Andrew. | " | " | " |
| " | Shaffer, Philip. | " | " | " |
| " | Sheffell, F. & Co. | " | " | " |
| " | Stauble, Charles. | " | " | " |
| " | Starker, M. | " | " | " |
| " | Stiger, Fred. | " | " | " |
| " | Teetsell, John. | " | " | " |
| " | Vedder, Charles. | " | " | " |
| " | Youngs, C. | " | " | " |
| Quarryville | Carnwright, Alphonso. | *U. B S CO.* | Saugerties | " |
| " | Coughlan, John. | " | " | " |
| " | Farming, John. | " | " | " |
| " | Fiero, Myron & Co. | " | " | " |
| " | Fitzpatrick, Daniel. | " | " | " |
| " | Foley, Kearn. | " | " | " |
| " | Gray, Morgan. | " | " | " |
| " | Harvey, Cornelius & Co. | " | " | " |
| " | Kelley, Patrick K. | " | " | " |
| " | Mack, Peter. | " | " | " |
| " | McLaughlin, Charles. | " | " | " |
| " | Miller, Abram & Co. | " | " | " |

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|---|---|---|---|---|---|
| " | Mower, John S. | " | " | " | " |
| " | O'Bryon, Samuel. | " | " | " | " |
| " | O'Rourke, John. | " | " | " | " |
| " | Quick, John A. | " | " | " | " |
| Sawkill | Bonsteel, Wm. | *H. B* | Kingston | | " |
| " | Brink, Edward. | " | " | | " |
| " | Brink, George. | " | " | | " |
| " | Brophy, James. | " | " | | " |
| " | Brophy, Wm. | " | " | | " |
| " | Brown, F. Isaac. | " | " | | " |
| " | Brown. Michael. | " | " | | " |
| " | Burkins, Charles. | " | " | | " |
| " | Burns, Bernard | " | " | | " |
| " | Burns, Patrick. | " | " | | " |
| " | Butler, Patrick. | " | " | | " |
| " | Canine, Hiram. | " | " | | " |
| " | Canty, Jno. | " | " | | " |
| " | Canty, Matthew. | " | " | | " |
| " | Canty, Thomas. | " | " | | " |
| " | Carle, Alonzo. | *H. B & R. & T.* | " | | " |
| " | Carle, Henry. | *H. B* | " | | " |
| " | Carney, Edward. | " | " | | " |
| " | Cartwright, U. S. | " | " | | " |
| " | Carr, James. | " | " | | " |
| " | Carr, Richard. | " | " | | " |
| " | Carroll, Henry. | " | " | | " |
| " | Carroll, Jno. | " | " | | " |
| " | Charleton, William. | *H. B & R. & T.* | " | | " |
| " | Coudrey, Wm. | *H. B* | " | | " |
| " | Crystal, Michael. | " | " | | " |
| " | Donaldson, Hugh. | " | " | | " |

HUDSON RIVER BLUESTONE — ULSTER COUNTY — (*Continued*).

| Post-office. | NAME. | LOCATION OF QUARRY. | |
|---|---|---|---|
| | | Town. | County. |
| Sawkill | Draffen, Geo. *R. & T* | Kingston | Ulster. |
| " | Draffen, Jno. *H B* | " | " |
| " | Felter, Albert. *H. B. & R. & T* | " | " |
| " | Fleming, R. *H. B* | " | " |
| " | Gleason, Wm. " | " | " |
| " | Glenon, Larry. " | " | " |
| " | Haggerty, John. " | " | " |
| " | Haggerty, Patrick. " | " | " |
| " | Hanley, Dennis. " | " | " |
| " | Hayes, Thos. " | " | " |
| " | Henderson, Thos. " | " | " |
| " | Hickey, Owen. " | " | " |
| " | Hulsair, Victor. " | " | " |
| " | Joy, Peter. " | " | " |
| " | Kearney, Edward. " | " | " |
| " | Kerr, James. " | " | " |
| " | Leahey, James. " | " | " |
| " | Leahey, Michael. " | " | " |
| " | Leahey, O'Brien. " | " | " |
| " | Leahey, Thomas. " | " | " |
| " | Lynch, Michael. " | " | " |
| " | Madigan, Chas. " | " | " |
| " | Madigan, Edward. " | " | " |

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|---|---|---|---|---|---|
| " | Malone, James. | " | | " | |
| " | Maning, Patrick. | " | | " | |
| " | Masten, Samuel. | " | | " | |
| " | Mickens, Wm. | " | | " | |
| " | McCaffrey, Chas. | " | | " | |
| " | McCarty, John. | " | | " | |
| " | McDonald, L. | " | | " | |
| " | McGurrie, Christopher. | " | | " | |
| " | Murphy, John. | " | | " | |
| " | Murray, James. | " | | " | |
| " | Neenan, David. | " | | " | |
| " | Peppard, Michael. | " | | " | |
| " | Purdy, Daniel. | " | | " | |
| " | Rack, Wm. | " | | " | |
| " | Roach, Timothy. | " | | " | |
| " | Ryan, James. | " | | " | |
| " | Ryan, William. | " | | " | |
| " | Sheehan, Daniel. | " | | " | |
| " | Sheehan, Patrick. | " | | " | |
| " | Sheeley, Charles, | *H. B., R. & T.* | | " | |
| " | Stall, Morgan, | *H. B.* | | " | |
| " | Starr, John. | " | | " | |
| " | Sweeney, Chas. | " | | " | |
| " | Sweeney, Michael. | " | | " | |
| " | Walsh, Wm. & Co. | " | | " | |
| " | Watson, Adam. | " | | " | |
| Stone Ridge | Ballard, Dewitt. | " | | Marbletown | |
| " | Barley, Edward. | " | | " | |
| " | Beatty, John. | " | | " | |
| " | Beatty, Marshall. | " | | " | |
| " | Bodily, David. | " | | " | |

HUDSON RIVER BLUESTONE — ULSTER COUNTY — (*Continued*).

| Post-office. | NAME. | | LOCATION OF QUARRY. | |
|---|---|---|---|---|
| | | | Town. | County. |
| Stone Ridge | Boice, Benj. | *H. B.* | Marbletown | Ulster. |
| " | Burley, Benj. | " | " | " |
| " | Buryer, James. | " | " | " |
| " | Bush, Benj. | " | " | " |
| " | Bush, C. A. | " | " | " |
| " | Bush, Geo. | " | " | " |
| " | Bush, Henry. | " | " | " |
| " | Bush, Joseph. | " | " | " |
| " | Bush, Luther. | " | " | " |
| " | Bush, Thos. | " | " | " |
| " | Carson, Andrew. | " | " | " |
| " | Christanna, W. | " | " | " |
| " | Du Bois, William. | " | " | " |
| " | Freer, James. | " | " | " |
| " | Grimm, Jno. | " | " | " |
| " | Jones, Alfred. | " | " | " |
| " | Krum, E. | " | " | " |
| " | Krum, Geo. | " | " | " |
| " | Krum, Henry. | " | " | " |
| " | Krum, R. | " | " | " |
| " | Krum. S | " | " | " |
| " | Krum, Wm. & Co. | " | " | " |
| " | Lockwood, M. | " | " | " |

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|---|---|---|---|---|---|---|---|
| " | ..... | Morey, Wm. A. | " | ..... | " | ..... | " |
| " | ..... | Osterhoudt, M. | " | ..... | " | ..... | " |
| " | ..... | Osterhoudt, Wm. | " | ..... | " | ..... | " |
| " | ..... | Ostrander, H. | " | ..... | " | ..... | " |
| " | ..... | Ostrander, Morris. | " | ..... | " | ..... | " |
| " | ..... | Palen, E. | " | ..... | " | ..... | " |
| " | ..... | Palen, J. | " | ..... | " | ..... | " |
| " | ..... | Palen, Lewis, | " | ..... | " | ..... | " |
| " | ..... | Palen, Theo. | " | ..... | " | ..... | " |
| " | ..... | Raymer, P. | " | ..... | " | ..... | " |
| " | ..... | Roosa, Geo. | " | ..... | " | ..... | " |
| " | ..... | Rosa, Aman | " | ..... | " | ..... | " |
| " | ..... | Rose, William. | " | ..... | " | ..... | " |
| " | ..... | Snidiger, Charles. | " | ..... | " | ..... | " |
| " | ..... | Snyder, Fred. | " | ..... | " | ..... | " |
| " | ..... | Strobridge, Geo. | " | ..... | " | ..... | " |
| " | ..... | Terwilliger, Jno. | " | ..... | " | ..... | " |
| " | ..... | Turner, C. C. | " | ..... | " | ..... | " |
| " | ..... | VanDermark, Gilbert | " | ..... | " | ..... | " |
| " | ..... | Van Dermark, L. | " | ..... | " | ..... | " |
| " | ..... | Van Hovenbergh, C. | " | ..... | " | ..... | " |
| " | ..... | Van Luerven, S. | " | ..... | " | ..... | " |
| " | ..... | Wager, Albert. | " | ..... | " | ..... | " |
| " | ..... | Wales, Wm. & Co. | " | ..... | " | ..... | " |
| " | ..... | Warner, Geo. | " | ..... | " | ..... | " |
| " | ..... | Whittaker, Wm. H. | " | ..... | " | ..... | " |
| " | ..... | Winchell, C. | " | ..... | " | ..... | " |
| " | ..... | Winchell, Geo. | " | ..... | " | ..... | " |
| " | ..... | Winchell, Wm. | " | ..... | " | ..... | " |
| " | ..... | Winnie, Geo. | " | ..... | " | ..... | " |
| " | ..... | Wood, Du Bois. | " | ..... | " | ..... | " |

HUDSON RIVER BLUESTONE — ULSTER COUNTY — (*Continued*).

| Post-office. | NAME. | | LOCATION OF QUARRY. | |
|---|---|---|---|---|
| | | | Town. | County. |
| Stone Ridge | Wood, James. | *H. B.* | Marbletown | Ulster. |
| " | Woolsey, J. C. | " | " | " |
| Stony Hollow | Brophy, Michael. | " | Hurley | " |
| " | Burk, James. | " | " | " |
| " | Cassidy, Owen. | " | " | " |
| " | Cowley, Daniel. | " | " | " |
| " | Cunningham, C. | " | " | " |
| " | Doran, James. | " | " | " |
| " | Halloran, Daniel. | " | " | " |
| " | Hyland, James. | " | " | " |
| " | Mullen, Thos. | " | " | " |
| " | Mulligan, Andrew. | " | " | " |
| " | Murphy, Michael. | " | " | " |
| " | Murtha, Michael. | " | " | " |
| " | Urall, James. | " | " | " |
| " | Urall, Patrick. | " | " | " |
| West Hurley | Ackerman, Julius. | *H. B. & R. T.* | " | " |
| " | Angevine, George. | *H. B.* | " | " |
| " | Angevine, Jacob. | " | " | " |
| " | Bahan, Patrick. | " | " | " |
| " | Bahan, William. | " | " | " |
| " | Baker, John G. | " | " | " |
| " | Baker, Orison. | " | " | " |

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|---|---|---|---|---|---|
| " | ..... | Ballard, Jesse. | " ..... | " ..... | " |
| " | ..... | Ballard, Sherman. | " ..... | " ..... | " |
| " | ..... | Ballard, Wm. H. | " ..... | " ..... | " |
| " | ..... | Barber, Wm. H. | " ..... | " ..... | " |
| " | ..... | Berrian, A. & Co., | *R. & T.* ..... | " ..... | " |
| " | ..... | Berryam, Henry. | *H. B* ..... | " ..... | " |
| " | ..... | Boice, Hewitt. | " ..... | " ..... | " |
| " | ..... | Boylon, F. | " ..... | " ..... | " |
| " | ..... | Brooks, John. | " ..... | " ..... | " |
| " | ..... | Bruce, David. | *H. B. & R. & T.* ..... | " ..... | " |
| " | ..... | Burling, John. | *H. B* ..... | " ..... | " |
| " | ..... | Cahill, James. | " ..... | " ..... | " |
| " | ..... | Carey, James. | " ..... | " ..... | " |
| " | ..... | Cassidy, Owen. | *R. & T.* ..... | " ..... | " |
| " | ..... | Chambers, Thomas. | *H. B* ..... | " ..... | " |
| " | ..... | Clancie, Wm. | " ..... | " ..... | " |
| " | ..... | Clark, Thomas. | *R. & T. & H. B* ..... | " ..... | " |
| " | ..... | Cleary, Wm. | *H. B.* ..... | " ..... | " |
| " | ..... | Colpaugh, F. | " ..... | " ..... | " |
| " | ..... | Colvin, James. | " ..... | " ..... | " |
| " | ..... | Conlin, Thomas. | " ..... | " ..... | " |
| " | ..... | Connear, Robert. | " ..... | " ..... | " |
| " | ..... | Conners, Charles.* | " ..... | " ..... | " |
| " | ..... | Conners, John. | " ..... | " ..... | " |
| " | ..... | Conners, Joseph. | " ..... | " ..... | " |
| " | ..... | Conners, Samuel. | " ..... | " ..... | " |
| " | ..... | Conners, Thomas. | " ..... | " ..... | " |
| " | ..... | Conroy, Edward. | " ..... | " ..... | " |
| " | ..... | Conroy, Thomas. | " ..... | " ..... | " |
| " | ..... | Cotter, John. | " ..... | " ..... | " |
| " | ..... | Cotter, Wm. | " ..... | " ..... | " |
| " | ..... | Cowley, James. | " ..... | " ..... | " |

HUDSON RIVER BLUESTONE — ULSTER COUNTY — (*Continued*).

| Post-office. | NAME. | | LOCATION OF QUARRY. | |
|---|---|---|---|---|
| | | | Town. | County. |
| West Hurley | Crosier, Hugh. | *H. B.* | Hurley | Ulster. |
| " | Cudney, Wm. | " | " | " |
| " | Cullen, James. | " | " | " |
| " | Cusack, Patrick. | " | " | " |
| " | Daley, Chas. | " | " | " |
| " | Davis, F. | " | " | " |
| " | Davis, James H. | " | " | " |
| " | De Vine, James. | " | " | " |
| " | Dimble, James. | " | " | " |
| " | Dolan, John. | " | " | " |
| " | Dolan, Patrick. | " | " | " |
| " | Douglas, G. | *R. & T.* | " | " |
| " | Douglas, L. | *H. B.* | " | " |
| " | Doyle, Jno. | " | " | " |
| " | Doyle, Timothy. | " | " | " |
| " | Du Bois, Robt. | " | " | " |
| " | Duel, C. | " | " | " |
| " | Duffy, Owen. | *H. B & R. & T.* | " | " |
| " | Duimond, Abram. | *H. B.* | " | " |
| " | Dummond Bros. | " | " | " |
| " | Durney, Patrick. | " | " | " |
| " | Duyer, William. | " | " | " |
| " | Eckert, James. | " | " | " |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| " | ..... | Eckert, Martin. | " | ..... | " | ..... | " |
| " | ..... | Elliot, Jno. | " | ..... | " | ..... | " |
| " | ..... | Ellsworth, Peter. | " | ..... | " | ..... | " |
| " | ..... | Eluyn, Geo. | " | ..... | " | ..... | " |
| " | ..... | Emrich, Chas. | " | ..... | " | ..... | " |
| " | ..... | Emrich, Isaac. | " | ..... | " | ..... | " |
| " | ..... | Emrich, James. | " | ..... | " | ..... | " |
| " | ..... | Everett & Co. | " | ..... | " | ..... | " |
| " | ..... | Fanning, Jno. | " | ..... | " | ..... | " |
| " | ..... | Farrell, Charles. | " | ..... | " | ..... | " |
| " | ..... | Finegan, Jno. | " | ..... | " | ..... | " |
| " | ..... | Finnigan, James. | " | ..... | " | ..... | " |
| " | ..... | Fitzgerald, M. | " | ..... | " | ..... | " |
| " | ..... | Fitzpatrick, Daniel. | " | ..... | " | ..... | " |
| " | ..... | Ford, Wm. *R. & T. & H. B* | | ..... | " | ..... | " |
| " | ..... | Foster, Jno. *H. B.* | | ..... | " | ..... | " |
| " | ..... | Gadd, Thos. | " | ..... | " | ..... | " |
| " | ..... | Goodwin, Jno. | " | ..... | " | ..... | " |
| " | ..... | Gorman, Thos. | " | ..... | " | ..... | " |
| " | ..... | Grant, Thomas. | " | ..... | " | ..... | " |
| " | ..... | Green, Alonzo. *H. B. & R. & T.* | | ..... | " | ..... | " |
| " | ..... | Green, James O. *H. B* | | ..... | " | ..... | " |
| " | ..... | Green, Wm. | " | ..... | " | ..... | " |
| " | ..... | Hale, Fred | " | ..... | " | ..... | " |
| " | ..... | Handrahan, Wm. | " | ..... | " | ..... | " |
| " | ..... | Hasbrook & Co. | " | ..... | " | ..... | " |
| " | ..... | Hendricks, George. | " | ..... | " | ..... | " |
| " | ..... | Hoffman, Barney. | " | ..... | " | ..... | " |
| " | ..... | Howard, James. *H. B. & R & T* | | ..... | " | ..... | " |
| " | ..... | Hyatt, David. *H. B.* | | ..... | " | ..... | " |
| " | ..... | Hyland, James. *R. & T.* | | ..... | " | ..... | " |

HUDSON RIVER BLUESTONE — ULSTER COUNTY — (*Continued*).

| Post-office. | NAME. | | Location of Quarry. | |
|---|---|---|---|---|
| | | | Town. | County. |
| West Hurley | Hyland, William. | *H. B* | Hurley | Ulster. |
| " | Hysen, James. | " | " | " |
| " | James & Co. | " | " | " |
| " | Jones, Charles. | " | " | " |
| " | Jones, Nathan. | " | " | " |
| " | Kelley, Crosby. | " | " | " |
| " | Kelley, Edward. | *H. B. & R. & T.* | " | " |
| " | Kelley, James. | *H. B.* | " | " |
| " | Kelley, Lawrence. | " | " | " |
| " | Kelley, Michael. | " | " | " |
| " | Kelley, Thomas. | " | " | " |
| " | Kilpatrick, John. | " | " | " |
| " | Kronser, Henry. | " | " | " |
| " | Lamb, Edward. | " | " | " |
| " | Lamb, James. | " | " | " |
| " | Landon, William. | " | " | " |
| " | Larkin, Thomas. | " | " | " |
| " | Leahey, James. | *R. & T* | " | " |
| " | Leahey, Thomas. | " | " | " |
| " | Lee, Walter. | *H. B.* | " | " |
| " | Lewis, Richard. | " | " | " |
| " | Linedes, Julius. | " | " | " |
| " | Long, John. | " | " | " |

| | | | | | |
|---|---|---|---|---|---|
| " | ..... | Madden, Michael. | " ..... | " ..... | " |
| " | ..... | Mahar, Peter. | " ..... | " ..... | " |
| " | ..... | Markle, Fred. | " ..... | " ..... | " |
| " | ..... | Markle, John. | " ..... | " ..... | " |
| " | ..... | Martin, David. | " ..... | " ..... | " |
| " | ..... | Martin, Jerry. | " ..... | " ..... | " |
| " | ..... | Mellon, Thos. | " ..... | " ..... | " |
| " | ..... | Miller, James. | " ..... | " ..... | " |
| " | ..... | Moran, Jno. | " ..... | " ..... | " |
| " | ..... | Moran & Smith. | " ..... | " ..... | " |
| " | ..... | McAuliffe, Thos. | " ..... | " ..... | " |
| " | ..... | McCalvey, Virgil. | " ..... | " ..... | " |
| " | ..... | McCann, M. | " ..... | " ..... | " |
| " | ..... | McCann, O. | " ..... | " ..... | " |
| " | ..... | McCarty, Jno. | *R. & T.* ..... | " ..... | " |
| " | ..... | McConnell, Jno. | *H. B* ..... | " ..... | " |
| " | ..... | McCullen, Jno. | " ..... | " ..... | " |
| " | ..... | McKeirnan, Edward. | " ..... | " ..... | " |
| " | ..... | McMahon, Patrick. | " ..... | " ..... | " |
| " | ..... | McMullen, C. | *H. B. & R. & T.* ..... | " ..... | " |
| " | ..... | McMullen, F. | *H. B* ..... | " ..... | " |
| " | ..... | McMullen, Jacob. | " ..... | " ..... | " |
| " | ..... | McSpirit, H. | " ..... | " ..... | " |
| " | ..... | McWilliams, Jno. | " ..... | " ..... | " |
| " | ..... | Near, Hiram. | " ..... | " ..... | " |
| " | ..... | Neenan, Jno. | *R. & T.* ..... | " ..... | " |
| " | ..... | Newberry, S. | *H. B* ..... | " ..... | " |
| " | ..... | O'Connell, Dennis. | " ..... | " ..... | " |
| " | ..... | O'Neill, James. | " ..... | " ..... | " |
| " | ..... | O'Neill, Jno. | " ..... | " ..... | " |
| " | ..... | O'Reardon, C. | *R. & T.* ..... | " ..... | " |

HUDSON RIVER BLUESTONE — ULSTER COUNTY — (*Continued*).

| Post-office. | NAME. | LOCATION OF QUARRY. | |
|---|---|---|---|
| | | Town. | County. |
| West Hurley | Osborn, Jno. *H. B* | Hurley | Ulster. |
| " | Overbaugh, Benj. " | " | " |
| " | Pierh, Robt. " | " | " |
| " | Pierh, Thos. " | " | " |
| " | Plass, Isaac. *H. B. & R. & T.* | " | " |
| " | Plutzader, Jacob. *H. B* | " | " |
| " | Purcell, Jno. " | " | " |
| " | Quick, C. " | " | " |
| " | Quick, William. " | " | " |
| " | Rack, Wm. *R. & T.* | " | " |
| " | Rice, Edward. *H. B.* | " | " |
| " | Rice, Pat. " | " | " |
| " | Riche, James & Co. " | " | " |
| " | Rowe, Geo. " | " | " |
| " | Rowe, Nicholas. *H. B. & R. & T.* | " | " |
| " | Ryan, James. *R. & T* | " | " |
| " | Saulpaugh, Daniel. *H. B* | " | " |
| " | Schryver, John. " | " | " |
| " | Scoville, Clinton. " | " | " |
| " | Scribner, Geo. *H. B. & R. & T.* | " | " |
| " | Scully, Joseph. *H. B.* | " | " |
| " | Scully, Thomas. " | " | " |
| " | Shader, Edward. " | " | " |

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|---|---|---|---|---|---|
| " | ..... | Shader, James. | " ..... | " ..... | " |
| " | ..... | Sheehan, John. | *R. & T.* ..... | " ..... | " |
| " | ..... | Sheehan, Robt. & Co. | *H. B.* ..... | " ..... ..... | " |
| " | ..... | Smedes, Julius, | *H. B. & R. & T* ... | " ..... | " |
| " | ..... | Smedes, Richard, | *H. B.* ..... | " ..... ..... | " |
| " | ..... | Smedes, Rufus. | " ..... | " ..... | " |
| " | ..... | Smedes, Wm. H. | " ..... | " ..... | " |
| " | ..... | Snyder, Martin. | " ..... | " ..... | " |
| " | ..... | Spring, Fred. | " ..... | " ..... | " |
| " | ..... | Spring, John. | " ..... | " ..... | " |
| " | ..... | Stewart, Wm. | " ..... | " ..... | " |
| " | ..... | Sweeney, And. | " ..... | " ..... | " |
| " | ..... | Tain, Daniel. | " ..... | " ..... | " |
| " | ..... ..... | Taylor, Wm. | " ..... | " ..... | " |
| " | ..... ..... | Tobin, Michael. | *H. B. & R. & T.* .... | " ..... | " |
| " | ..... | Toole Bros. | *H. B.* .... | " ..... | " |
| " | ..... | Van Steenburgh, Isaac. | " .... | " ..... | " |
| " | ..... | Van Steenburgh, Nathan. | " .... | " ..... | " |
| " | ..... | Van Steenburgh, P. E. | " .... | " ..... | " |
| " | ..... | Vaughn, John. | *R. & T.* ..... | " ..... | " |
| " | ..... ..... | Van Velser, O. | *H. B.* ..... | " ..... | " |
| " | ..... ... | Ward, Benj. | *H. B. & R. & T.* ..... | " ..... | " |
| " | ..... | Ward, George. | *H. B.* ..... | " ..... | " |
| " | ..... ..... | Warren, Wm. | " ..... | " ..... | " |
| " | ..... | White, Michael. | " ..... | " ..... | " |
| " | ..... | White, Patrick. | " ..... | " ..... | " |
| " | ..... | Wolven, E. | " ..... | " ..... | " |
| " | ..... | Wolven, J. C. | " ..... | " ..... | " |
| " | ..... | Wolven, N. | " ..... | " ..... | " |
| " | ..... | Wolven, Richard. | " ..... | " ..... | " |
| West Saugerties ..... | | Carn, Jacob. | *U. B. S. CO* .... | Saugerties ..... | " |

## Hudson River Bluestone — Ulster County — (*Continued*).

| Post-office. | NAME. | Location of Quarry. | |
|---|---|---|---|
| | | Town. | County. |
| West Saugerties | Hommel, Abram. *U. B. S. CO.* | Saugerties | Ulster. |
| " | Meyer, Wm. & Co. " | " | " |
| " | Schoonmaker, Nelson & Co. " | " | " |
| " | Snyder, Abram. " | " | " |
| " | Vogel, Simon. " | " | " |
| West Shokan | Boice, Lemuel. *H. B.* | Olive | " |
| Wilbur | Osterhoudt, J | Kingston | " |
| " | Sweeney Bros | " | " |
| Woodstock | Bonsteel, Elliot *H. B.* | Woodstock | " |
| " | Bonsteel, John. " | " | " |
| " | Bonsteel, Luke. " | " | " |
| " | Broner, Aaron. " | " | " |
| " | Broner, Edward. " | " | " |
| " | Broner, Howard. " | " | " |
| " | Broner, Lewis. " | " | " |
| " | Broner, Walter. " | " | " |
| " | Burland, John. " | " | " |
| " | Cashdollar, Wilbur. " | " | " |
| " | Castle, John. " | " | " |
| " | Degraff, O. " | " | " |
| " | De Valley, Wm. " | " | " |
| " | Elwyn, Larry. " | " | " |
| " | Gray, Wallace. " | " | " |
| " | Herrick, J. L. *H. B. & R. & T.* | " | " |
| " | Herrick, Judson. *H. B.* | " | " |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| " | ..... | Johnson, Geo. | " | ..... | " | ..... | " |
| " | ..... | Johnson, Henry. | " | ..... | " | ..... | " |
| " | ..... | Jones, John L. | " | ..... | " | ..... | " |
| " | ..... | Kellyhouse, E. | " | ..... | " | ..... | " |
| " | ..... | Kittle, Hiram. | " | ..... | " | ..... | " |
| " | ..... | Lasher, Addison. | " | ..... | " | ..... | " |
| " | ..... | Lasher, Albert. | " | ..... | " | ..... | " |
| " | ..... | Lasher, C. | " | ..... | " | ..... | " |
| " | ..... | Lenox, Sherman. | " | ..... | " | ..... | " |
| " | ..... | Longyear, E. | " | ..... | " | ..... | " |
| " | ..... | Moner, Noah L. | " | ..... | " | ..... | " |
| " | ..... | Moore, Horace. | " | ..... | " | ..... | " |
| " | ..... | Ricks, Charles. | " | ..... | " | ..... | " |
| " | ..... | Russell, Geo. | " | ..... | " | ..... | " |
| " | ..... | Russell, H. & Co. | " | ..... | " | ..... | " |
| " | ..... | Russell, John. | " | ..... | " | ..... | " |
| " | ..... | Russell, Wm. | " | ..... | " | ..... | " |
| " | ..... | Schoonmaker, F. | " | ..... | " | ..... | " |
| " | ..... | Schoonmaker, Sanford. | " | ..... | " | ..... | " |
| " | ..... | Shultis, A. | " | ..... | " | ..... | " |
| " | ..... | Shultis, Hiram. | " | ..... | " | ..... | " |
| " | ..... | Shultis, William. | " | ..... | " | ..... | " |
| " | ..... | Smith, Charles. | " | ..... | " | ..... | " |
| " | ..... | Smith, Granville. | " | ..... | " | ..... | " |
| " | ..... | Smith, H. | " | ..... | " | ..... | " |
| " | ..... | Smith, Simon & Co. | *H. B. & R. & T.* | ... | " | ..... | " |
| " | ..... | Sparling, F. | *H. B.* | ..... | " | ..... | " |
| " | ..... | Stoutenburgh L. | " | ..... | " | ..... | " |
| " | ..... | Stratton, Charles. | " | ..... | " | ..... | " |
| " | ..... | Van DeBogart, Rufus. | " | ..... | " | ..... | " |
| " | ..... | Van Etten, A. G. | *H. B. & R. & T.* | ..... | " | ..... | " |

HUDSON RIVER BLUESTONE — ULSTER COUNTY — (*Concluded*).

| Post-office. | NAME. | | LOCATION OF QUARRY. | |
|---|---|---|---|---|
| | | | Town. | County. |
| Woodstock | Van Etten, Stephen. | *H. B* | Woodstock | Ulster. |
| " | Wallace, Wm. | " | " | " |
| " | Winters, Peter. | " | " | " |
| " | Yeary, Charles. | " | " | " |
| " | Yeary, Philip H. | " | " | " |
| " | Yeary, Stephen. | " | " | " |

# SLATE.

* Parties producing in 1894. † Parties producing previous to 1894 now idle.

| Post-office. | NAME. | Location of Quarry. | |
|---|---|---|---|
| | | Town. | County. |
| Granville | Reese, Owens & Co | Granville | Washington. |
| " | Roberts, Eban J. | " | " |
| " | Williams, Wm. F. & Co | " | " |
| Hebron | Douglas, Mr | Hebron | " |
| Middle Granville | Eagle Red Slate Co. (Robert B. Pritchard, manager)* | Granville | " |
| " | Empire Red Slate Co.† | " | " |
| " | New Boston Red Slate Co. (A. T. Hughes, agent)* | Half mile from Middle Granville | " |
| " | New England Slate Co. | | " |
| " | Nixon, L. G* | Granville | " |
| " | Pen Rhyn Slate Co.* | " | " |
| " | Williams, Hugh† | " | " |
| North Granville | Herbert, I. S.† | Whitehall | " |
| Salem | Kays, Hugh | Salem | " |
| " | Williams, John M., Valley View Slate Quarry.† | " | " |
| Shushan | Dobbin, Wm. A.† | Jackson | " |
| Troy | Baker Red Slate Co., No. 10 Hall building † | Granville | " |
| Whitehall | Hall, R. A.* | " | " |

# LIMESTONE AND MARBLE.

* Parties producing in 1894. † Parties producing previous to 1894 now idle. L. S: Limestone. M: Marble.

| Post-office. | NAME. | Location of Quarry. | |
|---|---|---|---|
| | | Town. | County. |
| Amsterdam. | Austin, C. D | Amsterdam | Montgomery. |
| " | Hewitt, D. C.* *L. S.* | " | " |
| " | Van Derveer, T. B.* " | " | " |
| Auburn | Bennett, J. & Son.* " | Auburn | Cayuga. |
| " | Goodrich, L. S. & Son | " | " |
| Brasie Corners | Hall, R. G.* *L. S* | Macomb | St. Lawrence. |
| Buffalo, 314 Broadway | Armbruster, Joseph | Buffalo | Erie. |
| " 110 Franklin street | Buffalo Cement Co. Lim. | " | " |
| " 480 Hamburg street | Consumer's Lime Co.* *L. S* | Clarence | " |
| " 215 Oak street | Fogelsonger, D. R. & H | Amherst | " |
| " 187 LeRoy avenue | Gesl, John, Jr | Buffalo | " |
| " 2543 Main street | Kabel, Martin | " | " |
| " Cor. Huron and Oak sts. | Kehr, A. P. & Co.† *L. S* | Clarence | " |
| " 124 Broadway | Williamsville Lime Co | Amherst | " |
| Brownsville | | Brownsville | Jefferson. |
| Burlington, Vt | Burlington Mfg. Co.† *M* | Port Henry | Essex. |
| Canajoharie | Rapp, G.* *L S* | Canajoharie | Montgomery. |
| " | Shaper, A. E. " | " | " |
| Canton | Canton, Marble Co. Lim.* *M* | Canton | St. Lawrence. |
| Cassville | | Cassville | Oneida. |
| Chaumont | Adams Bros | Chaumont | Jefferson. |
| " | Duford & Sons | " | " |

| | | | |
|---|---|---|---|
| Cherry Valley | | Cherry Valley | Otsego. |
| Clarendon | | Clarendon | Orleans. |
| Clayton | | Clayton | Jefferson. |
| Cobleskill | | Cobleskill | Schoharie. |
| " | | " | " |
| Crown Point | | Crown Point | Essex. |
| Dolgeville | Dodge, Alfred.* *L. S.* | Oppenheim | Fulton. |
| Dover Plains | Ketcham, Geo. W | Dover Plains | Dutchess. |
| " | Preston Quarries | " | " |
| Fayetteville | Ransier, Huestis B.* *L. S.* | Manlius | Onondaga. |
| Fort Edward | Harris, John F.* *L. S.* | Whitehall | Washington. |
| Fort Plain | | Fort Plain | Montgomery. |
| Franklin Iron Works | Juhl, M.† *L. S.* | Augusta | Oneida. |
| Glens Falls | Glens Falls Co.* *L. S. & M.* | Queensbury | Warren. |
| " | Glens Falls Portland Cement Co | " | " |
| " | Jointa Lime Co.* *L. S* | " | " |
| " | Reynolds & Riordan.* *L. S.* | " | " |
| Gouverneur | Empire State Marble Co *M* | Gouverneur | St. Lawrence. |
| " | Gouverneur Marble Co.* *M* | " | " |
| " | Northern New York Marble Co.* *M.* | " | " |
| " | St. Lawrence Marble Co.* *M* | " | " |
| " | Whitney Marble Co *M* | " | " |
| Greenwich | Bennett, H. C.* *L. S.* | Greenwich | Washington. |
| Harrisville | Brady, Mary.† " | Diana | Lewis. |
| Hastings | | Hastings | Westchester. |
| Holland Patent | Hillidge, James G.* *L. S.* | Trenton | Oneida. |
| Hoosick Falls | Carey, Wm.* " | Hoosick | Rensselaer. |
| " | Dolan, Jno.* " | " | " |
| " | McCaffery, Cornelius | " | " |
| Howe's Cave | Howe's Cave Association* *L. S* | Howe's Cave | Schoharie. |
| Hudson | Jones, F. W. *M* | Hudson | Columbia. |

LIMESTONE AND MARBLE — (*Continued*).

| Post-office. | NAME. | Location of Quarry. | |
|---|---|---|---|
| | | Town. | County. |
| Jamesville | Alvord, E. B. & Co.* *L. S.* | DeWitt | Onondaga. |
| " | Burke & Burns | " | " |
| Johnson | House, S. M.* *L. S* | Wawayanda | Orange. |
| Jonesburg | Jones, Fred W.* *L. S.* | Greenport | Columbia. |
| Katsbaan | Valk & Beers.* " | Saugerties | Ulster. |
| Kingston | Donavan, D. E. | Kingston | " |
| " | Noone, Luke.† *L. S.* | " | " |
| " | O'Reilly, J. | " | " |
| Le Roy | Holmes, Geo. D. | Le Roy | Genesee. |
| " | Howell, Livingston D.* *L. S.* | " | " |
| " | Morris & Strobel.* *L. S.* | " | " |
| " | Pangrazio Bros.* " | " | " |
| " | Raymond & McGuire | " | " |
| Leyden | Auer, Melchior.* *L. S.* | Leyden | Lewis. |
| Little Falls | Jones, Hadley.† " | Manheim | Herkimer. |
| Lockport | Buffalo Stone Co. | Lockport | Niagara. |
| " | Heary, M. F.* *L. S.* | " | " |
| " | Lockner, Wm. E.* *L. S.* | " | " |
| " | Lockport Stone Co.† " | " | " |
| " | Stainthrope, C. N. & Co | " | " |
| " | Tuohey, P. H.* *L. S.* | " | " |
| " | Watson, T. G.* " | " | " |
| " | Whitmore, Chas.† " | " | " |

| | | | |
|---|---|---|---|
| " | Wilson, John H.* " | " | " |
| Lowville | Babcock, Wm. L.* " | Lowville | Lewis. |
| " | Carter, L. H.* " | " | " |
| " | Gowdy, Hiram | " | " |
| " | Lyman, M. M.* *L. S.* | " | " |
| " | Waters, John M.* " | " | " |
| Manlius | Loomis, Mr | Manlius | Onondaga. |
| Mapes Corners | Durland, Wilmot | Goshen | Orange. |
| Mendon | | Mendon | Monroe. |
| Middle Falls | Bates, H. B.* *L. S.* | Greenwich | Washington. |
| " | Grouty, Jas. M.* " | " | " |
| Middleville | Mosher, W. W.* " | Newport | Herkimer. |
| Newburgh | Brown Lime Co.* " | Newburgh | Orange. |
| Newark, N. J | Sayre, James R., Jr., & Co.† *L. S.* | Kingston | Ulster. |
| New Hamburg | | New Hamburg | Dutchess. |
| New Lebanon | | New Lebanon | Columbia. |
| Newport | O'Connor, Jno.* *L. S.* | Newport | Herkimer. |
| " | Reynolds, Mr | " | " |
| " | Sherman, Waldo | " | " |
| New York city (157 Broadway) | Snowflake Marble Co.* *M.* | Pleasantville | Westchester. |
| North Litchfield | Dixon & Lewis | Litchfield | Herkimer. |
| North Western | Van Dyke, Jno. H | Western | Oneida. |
| Norwich Corners | Ketchall, James, & Co | Litchfield | Herkimer. |
| Norwood (Box 126) | Hale, Geo. W.* *L. S.* | Potsdam | St. Lawrence. |
| " | Murray, Robt | Norfolk | " |
| Ogdensburg | Howard, John F.* *L. S.* | Oswegatchie | " |
| " | Nevin, Jno. H.* " | " | " |
| Onondaga Castle | Kelley, John, Jr.* " | Onondaga | Onondaga. |
| " | McElroy, P | " | " |
| Palatine Bridge | Frey, S. L. & A. B | Palatine | Montgomery. |
| " | Mohawk Valley Stone Co.* *L. S.* | " | " |

LIMESTONE AND MARBLE — (*Continued*).

| Post-office. | NAME. | Location of Quarry. | |
|---|---|---|---|
| | | Town. | County. |
| Palatine Bridge | Sharpes & Johnson | Palatine | Montgomery. |
| Perryville | Britt, O. F.† L. S | Perryville | Madison. |
| " | Hodge, F. W | " | " |
| Phelps | Johnson, Wm. H.* *L. S* | Phelps | Ontario. |
| Plattsburg | Behan, Hugh.* " | Plattsburg | Clinton. |
| " (Box 504) | Robinson, Thomas.* " | " | " |
| Pleasantville Station | Cornell Lime Co.* *M.* | Mt. Pleasant | Westchester. |
| Poughkeepsie | Hufcut, H. D.† L. S. | D ver | Dutchess. |
| Prospect | Jones, H. & L. N. | One mile south of Prospect village | Oneida. |
| " | Thomas, Evan T.* *L. S.* | Trenton | " |
| Ravena | De Friest, W.W. D. H.* " | Coeymans | Albany. |
| " | Hotaling, David.† " | " | " |
| " | McCullock, Conrad.* " | " | " |
| " | Hughes, Wm.* " | " | " |
| Rochester | Brown, Henry S. | Rochester | Monroe. |
| " | Foery & Kastner.* *L. S.* | " | " |
| " | Lauer & Hagaman.* " | " | " |
| " | Nellis, J. H.* " | " | " |
| " | Pike, R. E. | " | " |
| " | Smith, B. P.* *L. S* | Union Springs | Cayuga. |
| " | Whitmore, Rauber & Vicinus.* *L. S.* | R chester | Monroe. |
| Rondout | Gross, F. W.† *L. S.* | Kingston | Ulster. |

| | | | |
|---|---|---|---|
| " | Newark Lime and Cement Co | Whiteport | " |
| Sandy Hill | Drake & Stratton Co. (Limited).* *L. S.* | Queensbury | Warren. |
| " | Sandy Hill Quarry | Sandy Hill | Washington. |
| " | Sturtevant, D.* *L. S.* | South Glens Falls | Saratoga. |
| Saratoga Springs | Gorman, Michael | Milton | " |
| " | Lee, James A | " | " |
| " | Slade, Charles G | " | " |
| " | Wager, Isaac F.* *L. S.* | " | " |
| Sauquoit | Thurston, W. W | Paris | Oneida. |
| Scarsdale | Bates Quarry | Scarsdale | Westchester. |
| Schoharie | Becker, Clinton L.* *L. S.* | Schoharie | Schoharie. |
| " | Becker, David S. | " | " |
| " | Brown, Albert.† *L. S.* | " | " |
| Seneca Falls | Fisher, John.* " | Fayette | Seneca. |
| Sharon Springs | Smith, Edwin J | Sharon | Schoharie. |
| " | Smith, Jefferson.† *L. S.* | " | " |
| " | Smith, W. T.* " | " | " |
| Smith's Landing | Massino, Wm.* " | Catskill | Greene. |
| South Bethlehem | Callanan, P. " | Bethlehem | Albany. |
| South Sodus | Thornton, Walter | Sodus | Wayne. |
| Split Rock | Connors, James.* *L. S* | Onondaga | Onondaga. |
| " | Crowley, Cornelius.* " | " | " |
| " | Hughes Bros | " | " |
| Springfield Center | McCabe, Mr | Springfield | Otsego. |
| " " | McDonough, Wm.* *L. S* | " | " |
| Syracuse | Hughes Bros.* " | Onondaga | Onondaga. |
| Three Mile Bay | Barron, Jno. J.* " | Lyme | Jefferson. |
| Thurman | Pelletier, Jno.† *M.* | Thurman | Warren. |
| Ticonderoga | Joubert, Israel.* *L. S.* | Bolton | " |
| Towners | Penny, P. D.† " | Patterson | Putnam. |
| Tremont | Hillman, Caleb. *M* | Tremont | New York. |

## Limestone and Marble — (*Concluded*).

| Post-office. | NAME. | Location of Quarry. | |
|---|---|---|---|
| | | Town. | County. |
| Tribes Hill | Hurst, Henry & Son | Mohawk | Montgomery. |
| " | Shanahan, James.† *L. S.* | " | " |
| Troy | Cheney, W. E. & Son | Smith's Basin | Washington. |
| Tuckahoe | N. Y. Quarry Co.† *M.* | East Chester | Westchester. |
| " | Norcross Bros.* " | " | " |
| " | Tuckahoe Marble Co. " | " | " |
| Union Springs | Mosher, Daniel | | |
| " | Smith & Wood.* *L. S.* | Springport | Cayuga. |
| Utica | Callahan, Ed.* " | Trenton | Oneida. |
| " 44 Washington st | George & Griffith.* " | " | " |
| " | Shaleto & Hoff | " | " |
| Verplank | Bleackley, Clarence L | Cortlandt | Westchester. |
| Waterloo | Emmet, John | Fayette | Seneca. |
| " | Thomas, Loren.* *L. S.* | " | " |
| Warwick | Burt, Thomas.* " | Warwick | Orange. |
| Watertown | City of Watertown quarry | ? | Jefferson. |
| " | Cory & Fish | ? | " |
| " | Gould & Enos quarry | ? | " |
| " | Hunting, S. E.† *L. S.* | Pamelia | " |
| " | Phillips, Patrick | ? | " |
| " | Williams, E | ? | " |
| " | Williams, S | ? | " |
| Waterville | | Waterville | Oneida. |

| | | | |
|---|---|---|---|
| West Troy | Mark, George | Watervliet | Albany. |
| Whitehall | McLaughlin, Jno. *L. S* | Whitehall | Washington. |
| Wilbur | Sears, Alfred | Kingston | Ulster. |
| Williamsville | Young, J. S. & F. H | Williamsville | Erie. |
| Willsboro Point | Clark, Solomon W | Willsboro | Essex. |
| " | Frisbie, A. W.† *L. S* | " | " |
| Wolcott | Walker, Chas. J.† " | Butler | Wayne. |

# Clay.

The clay industries of New York have been exhaustively described in Bulletin No. 12 of the New York State Museum published this year and the reader is referred to that publication for a complete discussion of the subject.

The following brief extract from the above-mentioned bulletin will convey an idea of the condition of these industries.

The increasing value of clay for the manufacture of brick, tile, terra cotta, pottery, etc., and the ever growing demand for these products have given rise to an industry which is rapidly assuming vast proportions, and will in the near future become one of the most extensive and important in the country. Scattered over New York are extensive deposits of clay, many of them capable of being used for the manufacture of terra cotta, roofing tile and the coarser grades of pottery. To add to their value the most extensive beds of clay are situated in close proximity to the waterways and railroads which lead to the principal cities of the State. The commoner kinds of clay products, such as building brick, are marketed within the State, but the higher grades, such as terra cotta and roofing tile, have found good markets outside of New York.

The following table gives the receipts derived from the various branches of the clay industry during the year of 1892:

| | |
|---|---|
| Building, front and paving brick | $8,500,000 |
| Terra cotta | 100,000 |
| Sewer pipe | 260,000 |
| Fire brick* | 50,000 |
| Stoneware clay | 10,000 |
| | $8,920,000 |

*This does not include those manufactured in the State from clays obtained in other States.

As will be seen from the above statement bricks are the chief source of income. That the other branches of the clay industry are not further advanced is probably due in a large measure to the fact that the clay deposits of the State have been so little exploited or otherwise examined. Though many of the deposits have been opened up and are still being worked, there are numerous others scattered over the State which are still untouched. Few of the clays are found to be of sufficiently refractory character to be used for making fire brick, gas retorts, or other products which in use are subjected to a higher degree of heat; but for the manufacture of coarse pottery, terra cotta, paving brick, etc., many of the clays are eminently suited.

Within the last seven or eight years the manufacturers in New York have turned their attention toward the extensive beds of argillaceous shale which the State contains, and which on trial have given very satisfactory results. Several large firms are using them for the manufacture of sewer pipe, terra cotta paving brick and roofing tile. The shale formations at present used are the Salina, Hamilton and Chemung. The Hudson River shales are no doubt sufficiently argillaceous over many areas to be used for the manufacture of clay products, and the same may be said of the Niagara shale, which weathers to a red clay. A sample of this latter shale from Niagara Falls was first ground and then molded in a stiff mud machine and found to burn to a white brick, which was unaffected by a temperature of 2,500 degrees.

That the clays and shales of New York are comparatively undeveloped is, no doubt, largely due to the lack of knowledge of their extent and character. There seems, however, to be no reasonable doubt that they will in future become a valuable source of revenue.

## GEOLOGY AND GEOGRAPHY OF THE CLAY DEPOSITS.

Deposits of clay occur in nearly every county of New York. They belong to three geological periods, namely :

Quaternary, Tertiary and Cretaceous.

The clays of the first age are by far the most common. Those of the second are somewhat indefinite in extent, but they probably include a large number of the Long Island deposits. Of the

third class there are undoubted representatives on Long Island and Staten Island, as well as some additional ones on Long Island, which are questionable.

The clays of the mainland are all Quaternary so far as known. The problems of the Quaternary formations in New York are by no means solved, and it is not always possible to decide on the causes leading to the deposition of any particular body of clay by a single visit to the locality.

A great majority of the deposits are local and basin-shaped, lying in the bottoms of valleys which are often broad and fertile. They vary in depth from four to 20 or even 50 feet; as a rule they are underlain by modified drift or by bed rock. The clay is generally of a blue color, the upper few feet being weathered mostly to red or yellow. Stratification is rarely present, but streaks of marl are common. In some of the beds small pebbles, usually of limestone, are found, and these have to be separated by special machinery in the process of manufacture. In many instances the clay is covered by a foot or more of peat.

The basin-shaped deposits are no doubt the sites of former ponds or lakes, formed in many instances by the damming up of valleys, which have been filled later with the sediment of the streams from the retreating ice sheet. The valleys in which these deposits lie are usually broad and shallow. The broad flat valley in which the Genesee river flows from Mt. Morris to Rochester is a good example. The waters of the river were backed up by the ice for a time, during which the valley was converted into a shallow lake in which a large amount of aluminous mud was deposited. This material has been employed for common brick.

There are a number of these deposits which are of sufficient interest, geologically as well as commercially, to be mentioned in some detail.

At Dunkirk is a bed of clay having a depth of over 20 feet. The upper six feet are yellow and of a sandy nature, while the lower two-thirds is blue and of much better quality. It is mentioned by Prof. Hall* in his report, and is an instructive example of the manner in which the clay changes in color, downward.

* Geology of New York, 4th District, 1843, p. 382.

Around Buffalo is an extensive series of flats underlain by a red clay. A thin layer of sand suitable for tempering overlies the clay in spots, and limestone pebbles are scattered through it. Similar deposits occur at several localities to the north of the Ridge road and around Niagara Falls, also at Tonawanda and La Salle, to the north of Buffalo, as well as south of it along the shore of Lake Erie. No doubt much of this clay was deposited during the former extension of the Great Lakes.

Prof. Hall mentions deposits of clay at the following localities: at Linden one mile south of Yates Center;* along the shore of Lake Ontario east of Lewiston; on Cashaqua creek† deposits of tenacious clay due to the crumbling of the argillaceous green shales; in Niagara county‡ beds of clay are said to occur in every town, but they often contain a considerable amount of lime.

A bed of blue and red clay is being worked at Brighton near Rochester. This deposit lies near the head of Irondequoit bay and was deposited by some stream flowing into it. To the southeast of Rochester is a large esker which extends in a northeast direction nearly to Brighton. Mr. Upham, who has described this esker, considers that it was formed by a river which flowed between walls of ice and deposited the bed of clay above mentioned.*

Clays are also found at several points in the valley of the Oswego river from Syracuse to Oswego, an important one being at Three Rivers.

An extensive bed of red and gray clay, 20 acres in extent and horizontally stratified, occurs at Watertown. The deposit is 20 feet thick and rests on Trenton limestone.

Another deposit of considerable size is being worked at Ogdensburg. The clay is blue and has a depth of 60 feet.

In the southern portion of the State we find clays in abundance, in all the valleys, and lowlands. The extensive marshes near Randolph and Conewango are said to be underlain by clay throughout their entire extent.

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* Geology of New York, 4th District, 1843, p. 437.
† Ibid., p. 227.
‡ Ibid , p. 444.

At Levant, four miles east of Jamestown, Chautauqua county, is an interesting bed of blue clay underlying an area of several acres. It is probably of post-glacial age, and the section as determined by an artesian well-boring is:

| | | |
|---|---|---|
| Yellow sand | 4 | feet |
| Quicksand | 4 | inches |
| Yellow clay | 5 | feet |
| Blue clay | 70 | " |
| Hardpan | ... | " |
| Total thickness | 79 4 | " |

The owner of the clay bed states that leaves are often found between the layers of the clay at a depth of 15 or 20 feet.

At Breesport near Elmira is a bank of blue clay rising from the valley to a height of 50 feet. It was evidently formed when the valley was dammed up, and has subsequently been much eroded so that all that now remains is a narrow terrace along the side of the valley. A similar deposit is found at Newfield south of Ithaca. A moraine crosses the valley a mile or two south of it. Deposits of clay suitable for brick and tile occur extensively in the lowlands bordering the Mohawk river from Rome to Schenectady. The beds vary in thickness from six to 15 feet and are mostly of a red, blue, or gray color.

Among the most extensive and important clay formations occurring in New York are those of the Hudson valley. Here are deposits of two types. (1) Estuary deposits of fine stratified sand, yellow and blue clay, and (2) cross-bedded delta deposits, the materials of which are much coarser. The estuary deposits indicate a period of depression, and deposition in quiet water. The clay is chiefly blue, but where the overlying sand is wanting or is of slight thickness, it is weathered to yellow, this weathering often extending to a depth of 15 feet below the surface, and to a still greater depth along the line of fissures. The depth of oxidation is of course influenced by the nature of the clay; the upper portion weathering easily on account of its more sandy nature and hence looser texture.

Horizontal stratification is usually present, and the layers of clay are separated by extremely thin laminæ of sand. At some localities the layers of the clay are very thin and alternate with equally thin layers of sandy clay. This condition is found at Haverstraw, Croton, Dutchess Junction, Stony Point, Fishkill, Cornwall, New Windsor, Catskill and Port Ewen. At all of the above-mentioned localities except the last two, the clay is overlain by the delta deposits of rivers tributary to the Hudson, and the alternation of layers may be due to variations in the flow of the rivers emptying at those points, the sandy layers being deposited during period of floods. Isolated ice-scratched bowlders are not uncommonly found in the clay.

There is often a sharp line of division between the yellow weathered portion and the blue or unweathered part of the clay. The line of separation between the clay and overlying sand is also quite distinct in most cases. Of the blue and the yellow clay the former is the more plastic, but both effervesce readily with acid, due to the presence of three to six per cent. of carbonate of lime, and are therefore, properly speaking, marly clays. The clay is underlain by a bed of gravel, sand, hardpan, bowlder, till or bed rock. From Albany to Catskill the underlying material is a dark gray or black sand with pebbles of shale and quartz. The sand grains are chiefly of pulverized shale, the rest being silicious and calcareous with a few grains of feldspar and garnet. This sand can often be used for tempering, but at Catskill contains too much lime for this purpose,

From Catskill northward the clay is in most cases covered by but a foot or two of loam. South of Catskill the character of the overlying material varies.

## The Clays of the Champlain Valley.

The clays of the Champlain valley are estuary formations and of the same age as the Hudson river clays. They underlie terraces along the lake which have been elevated to a height of 400 feet above the lake surface. These terraces may be traced almost continuously from Whitehall, at the head of Lake Champlain, to the northern end of the lake and beyond it, but on account of the

extensive erosion which has taken place, they are usually narrow, and it is only at sheltered points, like Port Kent and Beauport, that they are specially prominent. The section involved is yellowish brown sand, yellowish brown clay and stiff blue clay, the latter being rather calcareous. The upper clay is somewhat silicious, and its coloring is due to the weathering of the lower layer. This formation has a thickness of about 15 feet, but sometimes, as at Burlington, it reaches a thickness of 100 feet. Isolated bowlders are occasionally found in the clays. The clays are usually horizontally stratified, and contortions of the layers are extremely rare. Numerous marine Quaternary fossils have been found in the overlying sands; the skeleton of a whale has also been found in them.

Openings have been made in these deposits for the purpose of obtaining brick clays at Plattsburg and a few other localities.

## Long Island Clays.

Clay beds are exposed along the north shore of the island and at several points along the main line of the Long Island railroad. There is still some doubt as to the exact conditions under which the beds of clay and gravel which form the greater portion of Long Island were deposited, but it is probable that the clays represent shallow water marine deposits of Cretaceous and Tertiary age. The overlying sands and gravels have in most instances a cross-bedded structure, with a south dip, and were probably deposited by swift currents as stated by Dr. Merrill.

The age of the clays is still largely a matter of speculation, and will probably remain so in many cases unless palæontologic evidence is forthcoming. Those on Gardiner's Island are quite recent, as shown by the contained fossils, and the clay on Little Neck, near Northport, is Cretaceous. The age of the Glen Cove clay is probably Cretaceous.

Cretaceous leaves in fragments of ferruginous sandstone have been found along the north shore of Long Island from Great Neck to Montauk Point,* but they are usually much worn and scratched and have evidently been transported from some distant source. The clays at Center Island, West Neck, Fresh

* A. Hollick, Notes on Geology of North Shore of Long Island, Trans. N. Y. Acad. Sci., XIII.

Pond and Fisher Island are very similar in appearance and composition, are very probably of the same age, possibly Tertiary, but we lack palæontologic or stratigraphic evidence. At West Neck the clay underlies the yellow gravel, and the latter is covered by the drift, so that is Pre-pleistocene.

The clays of Staten Island are chiefly Cretaceous, as proven by the fossils found in them. The chief outcrops are at Kreischerville, Green Ridge and Arrochar. Besides the clay there are several "kaolin" deposits.

# DIRECTORY OF CLAY MANUFACTURERS.

## Abbreviations used.

* Parties producing in 1894.
† Parties producing previous to 1894.
B. B.: Building Brick
C. B: Common Brick.
D. T.: Drain Tile.
E. W.: Earthen Ware.
F. B.: Fire Brick.
F. P.: Flower Pots.
H. B: Hollow Brick.
O. B.: Ornamental Brick.
Pa B.: Paving Brick.
P. B.: Pressed Brick.
R. B: Roofing Brick. Local name for H. B.
R. T.: Roofing Tile.
S. B: Stock Brick. Good quality of B. B.
S. P.: Sewer Pipe.
T. C: Terra Cotta.

| Post-office. | NAME. | Location of Clay Deposit. | |
|---|---|---|---|
| | | Town. | County. |
| Albany | Ammenheuser, Gottfried.* *E. W. & F. P* | Albany | Albany. |
| " | Babcock, J.* *C. B.* | " | " |
| " | Hunter, Alfred.* " | " | " |
| " | Jackson Bros.* *C. B., P. B., O. B., D. T.* | " | " |
| " | Moore, James C.* *C. B.* | " | " |
| " | Poutre, Antoine.* " | " | " |
| " | Rigney, Mrs T | East Greenbush | Rensselaer. |
| " | Smith, Ed. J.* *C. B* | Albany | Albany. |
| " | Stanwix & McCarty.* " | " | " |
| " | Winne, John.† " | Niskayuna | Schenectady. |
| Albion | Lafler, Charles L. | ? | Orleans. |
| Alfred | Celadon Terra Cotta Co. (Limited).* *T. C., R. T.* | Alfred | Allegany. |
| " | Rock Cut Clay Co.* *C. B., P. B* | " | " |
| Allen's Hill | Abbey, B. G.* *D. T.* | Richmond | Ontario. |
| Amenia | The Amenia Brick Co. | Amenia | Dutchess. |

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| Amsterdam | Grieme, Henry C.* *C. B.* | Amsterdam | Montgomery. |
| " | Hart, Frank.† " | Florida | " |
| Angola | Lyth, John & Son.* *D. T. & B. B.* | Evans | Erie. |
| Arlington | Flagler & Allen.* *C. B. & P. B.* | Poughkeepsie | Dutchess. |
| " | Rose, H. R. Sons.* *C. P. & Pa. B.* | " | " |
| Athens | Porter, J. R.* *C. B* | Athens | Greene. |
| " | Porter, J. W. | " | " |
| " | Porter, S. E. | " | " |
| " | Rider, W. W | " | " |
| " | Smith, John | " | " |
| Auburn | Harvey, Fred. W.* *C. B* | Auburn | Cayuga. |
| Baldwinsville | Mahoning, John | Baldwinsville | Onondaga. |
| " | Seneca River Brick Co | " | " |
| Barrytown-on-Hudson | Donaldson, Wm. G | Barrytown | Dutchess. |
| Bealsburg | Gay, Robt | Maplewood | Monroe. |
| Big Flats | Lowe, J. R | Big Flats | Chemung. |
| Binghamton | Ogden Brick Co.* *C. B* | Binghamton | Broome. |
| " | Wells & Brigham.* " | Union | " |
| Breesport | Empire State Pressed Brick Co | Horseheads | Chemung. |
| " | Locy Bros. | " | " |
| " | Townsend, P. M. C | " | " |
| Buchanan | Oldfield, C. W. & R. W.* *C. B.* | Cortland | Westchester. |
| Buffalo | Adams Brick & Terra Cotta Co.† *C. B.* | Cheektowaga | Erie. |
| " | Berrick, Chas. & Sons. | ? | " |
| " | Black Rock Sewer Pipe Co | | |
| " | Brush Bros.* *C. B., P. B., O. B., S. B.* | Buffalo | Erie. |
| " | Brush & Schmidt.* *C B, P. B., O. B.* | Aurora | " |
| " | Buffalo Sewer Pipe Co.* *S. P.* | Tonawanda | " |
| " | Dietschler, Henry | ? | " |
| " | Haake, Fred W.* *C. B. & S. B.* | Buffalo (East) | " |
| " | Hebert & Schusler | ? | " |

DIRECTORY OF CLAY MANUFACTURERS — (*Continued*).

| Post-office. | NAME. | LOCATION OF CLAY DEPOSIT. | |
|---|---|---|---|
| | | Town. | County. |
| Buffalo | Holmes, John | ? | Erie. |
| " | Kirkover, Louis | ? | " |
| " | Lancaster Brick Co.* *C. B. & H. B.* | Lancaster | " |
| " | Richards, J. P.* *C. B. & D. T.* | Cheektowaga | " |
| " | Savage, Thos.* *D. T.* | Buffalo | " |
| " | Schusler & Co | ? | " |
| Cambridge | Bronwell, Isaac W.† *C. B.* | White Creek | Washington. |
| Camillus | Bates, Wm | ? | Onondaga. |
| " | Brameley, P | ? | " |
| Canandaigua | Canandaigua Pressed Brick Works | ? | Ontario. |
| " | Gleason & Sidway* | Canandaigua | " |
| " | Willys & Hollis.* *C. B. & D. T.* | " | " |
| Canastota | Ballou, G. F.† *C. B* | Canastota | Madison. |
| Canton | O'Brien, Luke.* " | Canton | St. Lawrence. |
| Carthage | Griggs & Co | ? | Jefferson. |
| " | Houghton, Hiram.* *C. B. & D. T* | Wilna | " |
| " | Wrape & Peck.* *C. B* | " | " |
| Carthage Landing | Meade Bros.* " | Wappinger | Dutchess. |
| Catskill | Derbyshire Brick Co | | |
| " | Ferrier & Golden.* *C. B* | Catskill | Greene. |
| " | Washburn, Geo. W. & Co.* " | " | " |

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| Chittenango | Central, N. Y. Drain Tile and Br. Co. *D. T.* * | Sullivan | Madison. |
| " | Dibble, J. C | " | " |
| Coeymans | Brower, J. A. & L. K | Coeymans | Albany. |
| " | Corwin & McCullough.* *C. B* | " | " |
| " | Fevlit, Henry | " | " |
| " | Hardrick & Walsh | " | " |
| " | Niles & Slingerland | " | " |
| " | Slingerland, H. & Co.* *C. B* | " | " |
| " | Sutton & Sudderly.* " | " | " |
| Cohoes | Baeby, J | Cohoes | " |
| " | Murray & Burkboy | " | " |
| " | Newton, A. H | " | " |
| Cold Spring Harbor | Jones, Dr. Oliver.† *C. B* | Huntington | Suffolk. |
| Corning | Corning Brick and Terra Cotta Co*. *C. B., P. B., O. B., F. B., Pa. B., T. C.* | Corning | Steuben. |
| Cornwall-on-Hudson | Hedges, C. A. & A. P.* *C. B* | Cornwall | Orange. |
| Cortland | Phillips, H. M.* " | Cortland | Cortland. |
| Coxsackie | Cooper & Bell | | |
| " | Fitzgerald Sons, James.* *C. B* | Coxsackie | Greene. |
| " | Noble, F. W. & A | | |
| Coxsackie Station | Walsh Bros. & Co.* *C. B* | Stockport | Columbia. |
| Crescent | Newton, John B.* " | Halfmoon | Saratoga. |
| Croton Landing | Frost, Orrin | | |
| Croton-on-Hudson | Anchor Brick Co.* *C. B* | Cortland | Westchester. |
| " | Croton Brick Co.* " | " | " |
| " | Morton, John.* " | " | " |
| " | Nickerson, P. W. & Co | " | " |
| " | Underhill Brick Co.* *C. B., R. B., C. B* | " | " |
| Crugers | Avery, Thos | " | " |
| " | Bushnell, Henry | " | " |

DIRECTORY OF CLAY MANUFACTURERS.—(*Continued*).

| Post-office. | NAME. | LOCATION OF CLAY DEPOSIT. | |
|---|---|---|---|
| | | Town. | County. |
| Crugers | Carman, C | Cortland | Westchester. |
| " | Fisher, Adam | " | " |
| " | Fisher, W. H | " | " |
| " | Manning, J. H | " | " |
| " | Martin, John | " | " |
| Deerfield | Geo. F. Weaver's Sons.* *C. B* | Utica | Oneida. |
| Dolgeville | Kyser, A. C | ? | Herkimer. |
| Dunkirk | Hilton, John.* *C. B* | Dunkirk | Chautauqua. |
| Dutchess Junction | Bontecou, Geo. H.* " | Fishkill | Dutchess. |
| " | Budd, W. D.* " | " | " |
| " | Covert Bros. | " | " |
| " | Fishkill Brick Works | " | " |
| " | Fowler, Mr | " | " |
| " | Timoney, F | " | " |
| East Bethany | Peck, Richard.* *D. T. & B. B* | Bethany | Genesee. |
| East Greenbush | Dunn, Geo | East Greenbush | Rensselaer. |
| East Kingston | Brigham Bros | Ulster | Ulster. |
| " | Herrick, Wm. & Son.* *C. B* | " | " |
| " | Kerr, Geo. H | " | " |
| " | Manchester, D. S | " | " |
| " | Overbaugh, D. C | " | " |
| " | Rose & Co | " | " |

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| East Williston | ..... | New Hempstead | Queens. |
| Ellenville | ..... | ? | Ulster. |
| Elmira | ..... | Horseheads | Chemung. |
| " | ..... | " | " |
| " | ..... | " | " |
| " | ..... | ? | " |
| " | ..... | | |
| Evans | ..... | Elmira | " |
| Farmingdale | ..... | Evans | Erie. |
| Fishkill | ..... | Oyster Bay | Queens. |
| " | ..... | Fishkill | Dutchess. |
| " | ..... | " | " |
| " | ..... | " | " |
| " | ..... | Catskill | Greene. |
| Fishkill Landing | ..... | Fishkill | Dutchess. |
| " | ..... | " | " |
| Fishkill-on-the-Hudson | ..... | " | " |
| " | ..... | " | " |
| " | ..... | " | " |
| " | ..... | " | " |
| " | ..... | " | " |
| Florida | ..... | " | " |
| Fonda | ..... | " | " |
| Goshen | ..... | Goshen | Orange. |
| Fonda | ..... | Fonda | Montgomery. |

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| Shultz, Chas. A | ..... | |
| Staple, A. S | ..... | |
| Streeter & Hendricks.* | *C. B.* | ..... |
| Terry Bros.* | " | ..... |
| Washburn, J. T. & W. F | ..... | |
| Post, W. J.* | *C. B.* | ..... |
| Brady & Ryan | ..... | |
| Elmira Brick Co | ..... | |
| Elmira Sewer Pipe and Fire Brick Co. | | |
| Empire Brick Manufacturing Co.* | *C. B.* | |
| Hayes, H. O. & Son | ..... | |
| Weyer, J. Philip & Son.* | *C. B., P., B., O B., Pa. B. & T. C* | ..... |
| Bolton, Wm.* | *C. B* | ..... |
| The Queens County Brick Manufacturing Co.* | *C. B* | ..... |
| Dinan, Thos.* | " | ..... |
| Dinan & Butler | ..... | |
| McClure & Co | ..... | |
| McClean, Alex.† | *C. B.* | ..... |
| Page & Sherman | ..... | |
| Dow, Geo.* | *C. B* | ..... |
| Lahey, Wm | ..... | |
| Aldridge Bros. & Co.* | *C. B* | ..... |
| Brockway Brick Co.* | " | ..... |
| Dennings Point Brick Co.* | " | ..... |
| Ginley, James.* | " | ..... |
| Lahey, Wm.* | " | ..... |
| Page, John.* | " | ..... |
| Vernon, M. H.* | *C. B* | ..... |
| Davenport, Wm.* | *D. T.* | ..... |

DIRECTORY OF CLAY MANUFACTURERS — (*Continued*).

| Post-office. | NAME. | LOCATION OF CLAY DEPOSIT. | |
|---|---|---|---|
| | | Town. | County. |
| Fort Edward | Smith, Andrew.* *C. B.* | Fort Edward | Washington. |
| Fort Salonga | Longbothum, Geo. S.† " | Huntington | Suffolk. |
| Fulton | Fulton Fire Brick Co. | | |
| Garden City | Garden City Brick Co.* *C. B., P. B., O. B.* | Oyster Bay | Queens. |
| Geneva | Baldwin, A. A.† *C. B., P. B., Pa. B.* | Geneva | Ontario. |
| " | Delamorter, Wm. F.† *C. B* | " | " |
| " | Dixon & Whitewell | " | " |
| " | Dove, W. G.* *C. B* | " | " |
| " | Geneva Brick Co.† *C. B, P. B., O. B., Pa. B. & D. T* | Waterloo | Seneca. |
| Glasco | Finger, Wm. | Saugerties | Ulster. |
| " | Lent, Robert.* *C. B.* | " | " |
| " | Maginnis, Wm. & Son.* " | " | " |
| " | Porter, Wellington | " | " |
| " | Van Duzen & Co | " | " |
| " | Washburn Bros. & Co.* *C. B.* | " | " |
| Glens Falls | Glens Falls Brick Co.* " | Queensbury | Warren. |
| " | Glens Falls Terra Cotta & Brick Co.* *T. C, C. B., P. B., O. B* | Glens Falls | " |
| Gloversville | Eureka Pressed Brick Co.* *C. B.* | Johnstown | Fulton. |
| " | McDuffie, Henry.* " | " | " |
| " | McDuffie & Golden | | |

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| " | Stoutner, Wm.* *C. B* | Johnstown | Fulton. |
| Goshen | Goshen Brick Co. | | |
| " | Van Leuven, Isaac.* *C. B* | Goshen | Orange. |
| Gouverneur | Smith & Anthony.* " | Gouverneur | St. Lawrence. |
| " | Thompson, G. R. | " | " |
| Grand Island | Stengel, J. F.* *C. B* | Grand Island | Erie. |
| Grassy Point | Brophy, Patrick.* " | Haverstraw | Rockland. |
| " | Carroll & Co | " | " |
| " | Crowley, R. & J. R | " | " |
| " | Farley & Barnes | " | " |
| " | Grimes, Frank.* *P. B* | " | " |
| " | Heittinger & Co | " | " |
| " | Kelley & Burns | " | " |
| " | Malley, Thos.*. *C. B* | " | " |
| " | Morrisey & Co | " | " |
| " | Washburn, W. F. & Co | " | " |
| Greenport | Long Island Brick Co.* *C. B* | Southold | Suffolk. |
| Green Ridge | Atlantic Brick Co | ? | Richmond. |
| " | Kiernan & Monahan | ? | " |
| " | McCabe Bros.† *B. B* | Westfield | " |
| " | Wood & Keenan | ? | " |
| Haverstraw | Allison, B. J. & Co.* *C. B* | Haverstraw | Rockland. |
| " | Allison & Wood.* " | " | " |
| " | Allison, Wood & Keenan | " | " |
| " | Archer, M. A. Estate | " | " |
| " | Barney & Farley | " | " |
| " | Brennan, P. & Co | " | " |
| " | Buckley, Dunn & Co | " | " |
| " | Byrnes & Palmer | " | " |
| " | Cahill & Carroll | " | " |
| " | Christie, Henry & Son | " | " |

DIRECTORY OF CLAY MANUFACTURERS — (*Continued*).

| Post-office. | NAME. | LOCATION OF CLAY DEPOSIT. | |
|---|---|---|---|
| | | Town. | County. |
| Haverstraw | Clark & Goldrick | Haverstraw | Rockland. |
| " | Denton, Fowler & Son.* *C. B* | " | " |
| " | Dunn, John & Co | " | " |
| " | Dolan, Dunn & Butler | " | " |
| " | Dolan, Jos. & Co | " | " |
| " | Donnelly, A. & Son | " | " |
| " | Excelsior Brick Co.* *C. B* | " | " |
| " | Felter, John W.* " | " | " |
| " | Fowler & Son | " | " |
| " | Frederick, Theo | " | " |
| " | Goldrich, Philip.* *C. B & P. B* | " | " |
| " | Heittinger & Co.* *C. B* | " | " |
| " | Johnson & Myers | " | " |
| " | Levy, O'Brien & Co | " | " |
| " | Lynch, Patrick & Sons | " | " |
| " | Malley, T | " | " |
| " | Marks, C. A. & Bros | " | " |
| " | McGowan & McGowan | " | " |
| " | McGuire & Lynch.* *C. B* | " | " |
| " | McGuire, T. & Son.* " | " | " |
| " | Murray & Morrisey | " | " |
| " | Peck, T. G. & G. H.* *C. B* | " | " |
| " | Renn, E. N. & Co.* " | " | " |

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| " | Riley & Farley | " | " |
| " | Rowan & Scott.* *C. B.* | " | " |
| " | Shankey, Kelly & Renn | " | " |
| " | Shankey, T. & Son.* *C. B.* | " | " |
| " | Sherwood, G. S.* " | " | " |
| " | Snedecker Bros.* " | " | " |
| " | Theodore, F | " | " |
| " | Washburn, W. F. & Co * *C. B. Pa., B., S. P., D. T., T. C., R. T., B. B* | " | " |
| " | Wood & Allison.* *C. B.* | " | " |
| Herkimer | Mabbett, John J.* " | German Flats. | Herkimer. |
| Hermon | Frank, Nathan T.* " | DeKalb. | St. Lawrence. |
| " | Tillapaugh, E A.* " | " | " |
| Homer | Hall, Horace W.* " | Homer | Cortland. |
| " | Woodruff & Brown | " | " |
| Hoosick Falls | Dolan, John.† *B. B* | Hoosick | Rensselaer. |
| Hornellsville | Hornellsville Brick and Terra Cotta Co. | Hornellsville | Steuben. |
| " | Preston Brick Co.* *C. B., O. B, Pa. B.* | " | " |
| " | Signor Brick Co.* *C. B.* | " | " |
| Horseheads | Horseheads Brick Yard.* " | Horseheads | Chemung. |
| " | Townsend, P. M. C.† *C. B. & D. T.* | " | " |
| Hudson | Arkison Bros | Hudson | Columbia. |
| " | Bartlett, F. W | " | " |
| " | Fitzgerald, James & Sons | " | " |
| Huntington | Brown Bros | ? | Suffolk. |
| " | Talcott, C | " | " |
| Ingham Mills | Keyes, A | " | Herkimer. |
| Ithaca | Campbell & Wood.* *C. B., P. B., Pa. B.* | Newfield | Tompkins. |
| " | Wilcox, Seth | | |
| Jamestown | Jamestown Shale Paving Brick Co.* *C. B. & Pa. B* | Jamestown | Chautauqua. |

DIRECTORY OF CLAY MANUFACTURERS — (*Continued*).

| Post-office. | NAME. | LOCATION OF CLAY DEPOSIT. | |
|---|---|---|---|
| | | Town. | County. |
| Jamestown | Morley, C. A. | Jamestown | Chautauqua. |
| Johnson Creek | Parker, J. A. | ? | Niagara. |
| Johnstown. | Kilmer, Robert | " | Fulton. |
| Jones Point | De Groat, James A. | " | Rockland. |
| Kingston | Fredericks, Franklin | Ulster | Ulster. |
| " | Hutton, William | " | " |
| " | Main, Robert | " | " |
| " | Overbury, S. B. | " | " |
| Kirkville | Central City Brick Co.* *C. B., P. B., O. B.* | Kirkville | Onondaga. |
| Kreischerville | Kreischer Bros., New York Anderson Pressed Brick Co.† *P. B. & O. B.* | Westfield | Richmond. |
| Lancaster | Buffalo Star Brick Co.* *C. B.* | Lancaster | Erie. |
| " | Parker, J. W. | ... | ... |
| Lansingburg | Morrisey Thos. F.* *C. B.* | Lansingburg | Rensselaer. |
| LaSalle | Tompkins & Smith.* " | Niagara | Niagara. |
| Levant | McCusker M. J. & Son.* *C. B., P. B. & D. T.* | Ellicott | Chautauqua. |
| Little Valley | Rink John.* *C. B.* | Little Valley | Cattaraugus. |
| Lockport | Mossell, Aaron.* " | Lockport | Niagara. |
| Madrid | Watson, R. B.* " | Madrid | St. Lawrence. |
| Malden | Cooney & Farrell.† " | Malden | Ulster. |
| Malone | Dumas, Alex, & Wm.† " | Malone | Franklin. |

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| Massena Springs | Gibson H. S.* “ | Norfolk | St. Lawrence. |
| Matteawan | Mosier, Platt | ? | Dutchess. |
| Mayfield | Thompson, Ed | “ | Fulton. |
| Mechanicville | Mechanicville Brick Co.* *C. B. & Pa. B* | Half Moon | Saratoga. |
| Middleburg | Underwood, A | ? | Schoharie. |
| Middle Falls | Pullman, H | “ | Washington. |
| Middle Granville | Pepper, J. H.* *C. B.* | Granville | “ |
| Middletown | Robertson & Ridgeway | ? | Orange. |
| “ | Smith & Wood | “ | “ |
| “ | Wheeler, O. B | “ | “ |
| Mohawk | Coe, Samuel E.* *C. B.* | German Flats | Herkimer. |
| Montrose | Bellefenelle, Edward.* “ | Cortland | Westchester. |
| “ | Bushnell, James F.* “ | “ | “ |
| “ | Cannon, C | “ | “ |
| “ | Hyatt, Chester W | “ | “ |
| “ | Montrose Point Brick Co | “ | “ |
| “ | Peck, E. H. & W. J | “ | “ |
| Newburgh | Bourne, Clayton.* *C. B.* | Wappingers | Dutchess. |
| “ | Brewer, Warren | New Windsor | Orange. |
| “ | Brown, W. R | “ | “ |
| “ | Carson, David.† *C. B.* | “ | “ |
| “ | Christie, Mrs. E. L | “ | “ |
| “ | Davidson Bros | “ | “ |
| “ | Gillies, James M.* *C. B.* | “ | “ |
| “ | Jover, J. J | “ | “ |
| “ | Lahey, William.* *C. B.* | “ | “ |
| “ | Lang, E.* “ | “ | “ |
| “ | Newburgh Tile Works | “ | “ |
| “ | Walsh, E. A | “ | “ |
| “ | Whitbeck, J. A | “ | “ |

DIRECTORY OF CLAY MANUFACTURERS — (*Continued*).

| Post-office. | NAME. | LOCATION OF CLAY DEPOSIT. | |
|---|---|---|---|
| | | Town. | County. |
| New Paltz | Lowe, Fred | ? | Ulster. |
| " | New Paltz Brick Co | " | " |
| New York | Hammond, W. K.* *C. B* | Huntington | Suffolk. |
| Niagara Falls | Niagara Brick Co.* " | Lewiston | Niagara. |
| Northport | Brodsky, Isaac.* " | Huntington | Suffolk. |
| " | Sammis, R.* " | " | " |
| Oakfield | Drake, George L.* *D. T.* | Oakfield | Genesee. |
| Ogdensburg | Paige Bros | Ogdensburg | St. Lawrence. |
| Olean | McMurray, J. C. & A | ? | Cattaraugus. |
| Oneida | Hall, F. L. | " | Madison. |
| Oneonta | Crandall & Marble | Oneonta | Otsego. |
| " | Denton, J. H. & Son | " | " |
| Oswego Falls | Edgarton, W. D.* *C. B* | Granby | Oswego. |
| " | Fletcher, A. B.* " | " | " |
| Owasco | Lester, Alfred.* *P. B. & D. T.* | Owasco | Cayuga. |
| Oyster Bay | Dunn, Dolan & Co.* *C. B* | Oyster Bay | Queens. |
| Peekskill | Bonner Brick Co.* " | Cortland | Westchester. |
| " | Carman, Charles | " | " |
| " | Cole & Bonner.* *C. B* | " | " |
| " | Travis, Cyrus.* " | " | " |
| Plattsburg | Gilliland & Day.* " | Plattsburg | Clinton. |
| " | Vaughn, Chas. W.* " | " | " |
| Port Ewen | Kline, Jacob.* " | Esopus | Ulster. |

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| " | Port Ewen Brick Co | " | " |
| Port Jefferson | Lillis, Johanna.* *C. B., P. B., F. B* | Brookhaven | Suffolk. |
| Poughkeepsie | Caire, Adam.* *F. P* | Poughkeepsie. | Dutchess. |
| " | Fishkill Brick Works.* *C. B.* | Fishkill | " |
| Randolph | Turner, J | | |
| Raymondsville | Coats, Wm.* *C. B* | Norfolk | St. Lawrence. |
| Rochester | New York Hydraulic Pressed Brick Co.* *P. B. & O. B* | Canandaigua | Ontario. |
| " | Otis, Gorsline* *S. P* | Brighton | Monroe. |
| " | Rochester Brick and Tile Manufacturing Co.* *C. B., Pa. B., D. T., B B.* | " | " |
| " | Rochester German Brick and Tile Co.* *C. B* | " and Chili | " |
| " | Rochester Sewer Pipe Co | " | " |
| Rodman | Gotham, John | ? | Jefferson. |
| " | Whitney, Mrs. E. D | " | " |
| Rome | Parry, Watkyn W.† *C. B* | Rome | Oneida. |
| Romulus | Yerkes, J. M. & Son.* *C. B. & D T* | Romulus | Seneca. |
| Rondout | Cooney, John J | | |
| " | Course, Henry | ? | Ulster. |
| " | Coykendall, S. D.* *C. B.* | Esopus | " |
| " | Everburgh, D. C. | Kingston | " |
| " | Staples, A. S.* *C B* | " | " |
| " | Terry Bros.* " | " | " |
| Roseton | Jova Brick Works.* " | Roseton | Orange. |
| " | Rose, J. C | " | " |
| Sag Harbor | Sag Harbor Brick Co. (Limited).* *C. B.* | Southampton | Suffolk. |
| Sangerfield | Corse, H | Sangerfield | Oneida. |
| " | Haven, P. B. & Son.* *C. B* | " | " |

DIRECTORY OF CLAY MANUFACTURERS — (*Continued*).

| Post-office. | NAME. | LOCATION OF CLAY DEPOSIT. | |
|---|---|---|---|
| | | Town. | County. |
| Saratoga Springs | Davidson, David.* *C. B. & Pa. B.* | Greenfield | Saratoga. |
| " | Williams, Chauncey L.* *C. B., O. B. & Pa. B.* | " | |
| Saugerties | Porter, Wellington | Saugerties | Ulster. |
| Schenectady | Case, Sherman A † *C. B.* | Glenville | Schenectady. |
| Seneca Castle | Childs, A. S.* *D T.* | Seneca | Ontario. |
| Schodack Landing | Brousseau, Ed. | Stuyvesant | Columbia. |
| Skaneateles | Webber, F. | ? | Onondaga. |
| Southampton | Graham, Wm. T. | " | Suffolk. |
| South Bay | Stephens, Clinton | " | " |
| Southold | Sanford, C. L.* *C. B.* | Southold | " |
| South Plattsburg | McCarty, James * " | Plattsburg | Clinton. |
| South Trenton | Garrett, Henry L.* " | Trenton | Oneida. |
| Spencer | Spencer Brick Co.* " | Spencer | Tioga. |
| Spring Brook | Northrup, E. B | ? | Erie. |
| Springville | Churchill, A. C | ? | " |
| Stanley | Preston, Wm.* *C. B. & D. T.* | Gorham | Ontario. |
| St. Johnsville | Smith, J. S | St. Johnsville | Montgomery. |
| Stockport | Washburn & Barnes | ? | Columbia. |
| Stony Point | Farley & Barnes | | |
| " | Marks & Meehan.* *C. B.* | Stony Point | Rockland. |
| " | Reilly & Clark.* " | " | " |
| " | Reilly & Rose.* " | " | " |

| | | | |
|---|---|---|---|
| Storm King | Mosher Bros.† " | Fishkill | Dutchess. |
| Syracuse | Ballard, Robert | ? | Onondaga. |
| " | Brophy, John.* *C. B.* | Salina | " |
| " | Brown Brick Co | ? | " |
| " | Callaway, E. H | ? | " |
| " | Central City Brick Co.* *P. B. & O. B.* | Manlius | " |
| " | Central New York Drain Tile and Brick Co.* *D. T.* | Chittenango | Madison. |
| " | Kennedy, Frank | ? | Onondaga. |
| " | Merrick, C. & L.* *C. B., P. B, B. B. H. B.* | Dewitt | " |
| " | New York Brick and Paving Co.* *C. B. & Pa. B* | Clay | " |
| " | Nolan, Timothy | ? | " |
| " | Peck, Geo. W. & Son | ? | " |
| " | Preston, Patrick | ? | " |
| " | Syracuse Pressed Brick Co.* *C. B. & P. B* | Onondaga | " |
| Thiells | Felter & Mather | Haverstraw | Rockland. |
| Throopsville | Laden, John | ? | Cayuga. |
| Tomkins Cove | McGuire, T. C.* C. B | Haverstraw | Rockland. |
| " | Rodemond, R. & Co | " | " |
| Tonawanda | Riesterer, M. & Son.* *C. B.* | Tonawanda | Erie. |
| Troy | Dennis, John | | |
| " | Ferguson, Alex.* *C. B., S. B, B. B.* | Troy | Rensselaer. |
| " | Ostrander Fire-Brick Co.* *F. B* | Westfield | Richmond. |
| " | Painton, C. R | | |
| " | Roberts, J | | |
| Utica | Callahan & Doyle.* *C. B., P. B. & O. B.* | Marcy | Oneida. |
| " | Central New York Pottery | ? | " |

DIRECTORY OF CLAY MANUFACTURERS — (*Concluded*).

| Post-office. | NAME. | LOCATION OF CLAY DEPOSIT. | |
|---|---|---|---|
| | | Town. | County. |
| Utica | Utica Brick Works | ? | Oneida. |
| " | White, N. A. & Co | ? | " |
| " | Wiley, Wm | ? | " |
| Verplank | Avery & Mackey | Verplank | Westchester. |
| " | King & Lynch.* *C. B.* | " | " |
| " | Mackey, Robert | " | " |
| " | Mackey, Wm | " | " |
| " | McGuire, B. G | " | " |
| " | O'Brien, Philip | " | " |
| " | O'Brien, McConnon & Vaughey.* *C B* | Fishkill | Dutchess. |
| Warners | Onondaga Vitrified Brick Co.* *C. B., P. B., Pa. B., D. T., B. B* | Van Buren | Onondaga. |
| Warsaw | Cheeney, J | ? | Wyoming. |
| Waterloo | Whartenby, Alex.* *D. T* | Waterloo and Fayette | Seneca. |
| " | Whiteside, M | " | " |
| Watertown | Watertown Pressed Brick Co.* *C. B., P. B, O. B* | Pamelia | Jefferson. |
| West Bloomfield | Webb, Geo. N.* *D. T* | West Bloomfield | Ontario. |
| West Haverstraw | Hurley, John F.* *C. B* | Stony Point | Rockland. |
| West Troy | Tupper, H. D.* " | Watervliet | Albany. |
| " | Wiswall, E. S | " | " |
| Whitehall | Adams, Jeremiah.* *C. B* | Whitehall | Washington. |
| " | Culbertson, D. & Co | " | " |

# Lime and Cement.

Lime is produced throughout the State on the outcrops of the Calciferous, Trenton, Niagara and Helderberg limestones. Some of the chief localities are Glens Falls, Howe's Cave, Rochester, Buffalo, Sing Sing, Pleasantville and Tuckahoe. Hydraulic cement or water lime is chiefly produced from beds of hydraulic limestone in the Water lime group at the base of the lower Helderberg. Rondout and Rosendale, Howe's Cave and the vicinity of Syracuse are important commercially in this product. At Akron and Buffalo much water lime is made, but from a lower formation, probably the Salina Group.

Portland cement is made from marl and clay at Warner's near Syracuse, and at Wayland, Steuben county; from lime and clay near Glens Falls and at other points.

## Limestone for Flux.

In the present depressed condition of the manufacture of iron in New York, the production of limestone for flux is but a small industry.

# DIRECTORY OF PRODUCERS OF LIME AND CEMENT.

* Parties producing in 1894. † Parties producing previous to 1894, now idle. L, Lime. C. Cement.

| Post-office. | NAME. | Location of Quarry. | |
|---|---|---|---|
| | | Town. | County. |
| Accord | Baker, A. G | Rochester | Ulster. |
| " | Baker, John A | " | " |
| " | Baker, Simon | " | " |
| " | Christiana, Nelson | " | " |
| " | Gordon, Eugene | " | " |
| " | Myers, A | " | " |
| Akron | Akron Cement Co | Newstead | Erie. |
| " | Jebs Cement Works | " | " |
| " | Newman, H. L. & W. C.* *C* | " | " |
| " (General office, Buffalo.) | The Cummings Cement Co. *C* | " | " |
| Albion | Johnson, B | Barre | Orleans. |
| " | Staines, Charles | " | " |
| " | Staines, Henry | " | " |
| " | Staines, Thomas F.* *L* | " | " |
| Amsterdam | Hewitt, D. C.* *L* | Amsterdam | Montgomery. |
| " | Wilber, C | " | " |
| Batavia | Heintz, John & Sons | Batavia | Genesee. |
| " | Merrill, John.* *L* | " | " |
| Bellona | Alexander, John | Benton | Yates. |
| " | Scott, D. M | " | " |
| Bigelow | Williams, Chas. & Co.* *L* | De Kalb | St. Lawrence. |
| Boonville | Lee, Albert J.* *L* | Boonville | Oneida. |

| | | | |
|---|---|---|---|
| Brasie Corners | Fleming, Walter.* *L* | Macomb | St. Lawrence. |
| " | Hall, Robert G.* *L* | " | " |
| " | Tully, Richard | " | " |
| Buffalo, 200 Main street | The Cummings Cement Co.* *C* | Newstead | Erie. |
| " 480 Hamburg street | Straub, Peter G.* *L* | Clarence | " |
| Canajoharie | Allen, Wm. *L* | Canajoharie | Montgomery. |
| Canandaigua | Brown, G.* *L* | Canandaigua | Ontario. |
| " | Wells, John.* *L* | " | " |
| Catskill | Palmer, H. P.* *L* | Catskill | Greene. |
| Chaumont | Capley Bros.* *L* | Lyme | Jefferson. |
| Chazy | Chazy Marble Lime Co. (C. H. Jones, general manager).* *L* | Chazy | Clinton. |
| " | Goss, L. M.* *L* | " | " |
| Cherry Valley | Bastian, Wm.* *L* | Cherry Valley | Otsego. |
| " | Eldridge, O. H.* *L* | " | " |
| Chittenango Falls | Keeler, Chas.† *L. & C.* | Fenner | Madison. |
| Climax | Day, John | Coxsackie | Greene. |
| Cobleskill | Baard, Frank.* *L* | Cobleskill | Schoharie. |
| Collinsville | Jones, Hugh D.* *L* | West Turin | Lewis. |
| " | Williams, B. B.* *L* | " | " |
| Columbia | Manning, A | Columbia | Herkimer. |
| Coxsackie | Day, Ambrose.* *L* | Coxsackie | Greene. |
| Cranberry Creek | Kegg, Willard.* *L* | Northampton | Fulton. |
| Crary's Mills | Church, Ashley.* *L* | Potsdam | St. Lawrence. |
| East Penfield | Hanson, W | Penfield | Monroe. |
| East Pitcairn | Van Patten, F. A.* *L* | Pitcairn | St. Lawrence. |
| Ellenville | Sheley, C. N.* L | Wawarsing | Ulster. |
| Fayetteville | Bangs & Gaynor.* *C* | Manlius | Onondaga. |
| " | Sheedy, Thos. W.* *C* | " | " |
| Glens Falls | Glens Falls Co.* *L* | Queensbury | Warren. |
| " | Jointa Lime Co.* *L* | " | " |

DIRECTORY OF PRODUCERS OF LIME AND CEMENT — (*Continued*).

| Post-office. | NAME. | LOCATION OF QUARRY. | |
|---|---|---|---|
| | | Town. | County. |
| Glens Fallls | Morgan Lime Co.* *L* | Moreau | Saratoga. |
| " | Sherman Lime Co.* *L* | Queensbury | Warren. |
| " | Glens Falls Portland Cement Co | " | " |
| Gloversville | Mayfield Lime Co.* *L* | Mayfield | Fulton. |
| Gouverneur | Abbot, J. B.* *L* | Gouverneur | St. Lawrence. |
| " | Potter, Chas. A.* *L* | Fowler | " |
| " | Wright, H. J.* *L* | " | " |
| Hailsboro | Patten, Chas | " | " |
| Harris Hill | Fiegle, August.* *L* | Clarence | Erie. |
| Harrisville | Brady, Mary.† *L* | Diana | Lewis. |
| Hayts Corners | Yarnell, E. J.† *L* | Romulus | Seneca. |
| Hart Lot | Carrigan, P. C.* | Skaneateles | Onondaga. |
| Hickory | Ingram, Vilas.* *L* | Macomb | St. Lawrence. |
| " | Perin, William.* *L* | " | " |
| Howe's Cave | Howe's Cave Association.* *L. & C.* | Cobleskill | Schoharie. |
| " | Howe's Cave Lime and Cement Co.* *L. & C.* | Howe's Cave | " |
| Ingham Mills | Butler, Sherman | Manheim | Herkimer. |
| Jamesville | Alvord, E. B. & Co.* *L. & C.* | De Witt and Lafayette. | Onondaga. |
| " | Dunlap, R. & Co | De Witt | " |
| Joy | Horn & Burcroff | Sodus | Wayne. |
| Kattsbaan | Fiero, William.* *L* | Saugerties | Ulster. |
| Kerhonkson | Gordon, E. H.* *L* | Rochester | " |

| | | | |
|---|---|---|---|
| Le Roy | Heinlich, John.* *L* | Le Roy | Genesee. |
| Lincoln | Shorte, Fred. | Walworth | Wayne. |
| Lowville | Waters, John M.* *L* | Lowville | Lewis. |
| Manlius | Behan's, James, Estate.* *L. & C.* | Manlius | Onondaga. |
| " | Brown Cement Co | " | " |
| Marbletown | Davenport, Solomon | Marbletown | Ulster. |
| Marcellus | Malley, William | Marcellus | Onondaga. |
| Marcellus Falls | Sherman, J. N.* *C.* | " | " |
| Mayfield | Dennie Bros | Mayfield | Fulton. |
| " | Warner, S. B.* *L.* | " | " |
| Mettacahonts | Gray, Stephen.* | Rochester | Ulster. |
| Middle Falls | Bates, H. B.* *L* | Greenwich | Washington. |
| " | Cepperly & Hegeman | " | " |
| " | Cipperly, Jno | " | " |
| Millgrove | Shoff, B. O | Alden | Erie. |
| Mohawk, Box 21 | Humphrey, Jay W.* *L.* | Columbia | Herkimer. |
| Monroe | Cross, Jno | Monroe | Orange. |
| Munnsville | Bassett, W. H.* *L* | Stockbridge | Madison. |
| Napanoch | Young & Humphrey | Wawarsing | Ulster. |
| Natural Bridge | Ashcraft, F. E.† *L.* | Diana | Lewis. |
| " | Hall, E. & W.* " | Wilna | Jefferson. |
| " | Loveless, E. J | " | " |
| Newburgh | The Brown Lime Co.* *L.* | Newburgh | Orange. |
| Newcomb | Anderson & Maynehan.* " | Newcomb | Essex. |
| New York | Duryee Portland Cement Co.† *C.* | Montezuma | Cayuga. |
| " | Newark & Rosendale Lime and Cement Co.* *L. & C.* | Whiteport | Ulster. |
| " | O'Connell & Hillery*. *L.* | Tuckahoe | Westchester. |
| Niagara Falls | Messing, Bernard.* " | Niagara | Niagara. |
| North Litchfield | Davies, Albert R.* " | Litchfield | Herkimer. |
| " | Dickson, Chas.† " | " | " |

DIRECTORY OF PRODUCERS OF LIME AND CEMENT — (*Continued*).

| Post-office. | NAME. | LOCATION OF QUARRY. | |
|---|---|---|---|
| | | Town. | County. |
| North Litchfield | Holland, Geo. E.* *L* | Litchfield | Herkimer. |
| " | Salisbury, John E.* " | " | " |
| North Tonawanda | Calkins & Co | Tonawanda | Erie. |
| North Western | Vale, Jno. D.* *L* | Western | Oneida. |
| Norwich Corners | Thurston, W. W | Litchfield | Herkimer. |
| Ogdensburg | Howard, John F.* *L* | Oswegatchie | St. Lawrence. |
| Oriskany Falls | Putnam & Clark | Augusta | Oneida. |
| Perryville | Hodge, Fred | Sullivan | Madison. |
| " | Worlock, Cyrus.* *L. & C* | " | " |
| Pine Island | Brown, B. T.† *L* | Warwick | Orange. |
| " | Elston, Chas | " | " |
| Plattsburg | Pray, G. W.† | Peru | Clinton. |
| Pleasant Valley | Russell, Evert.* *L* | Pleasant Valley | Dutchess. |
| Prospect | Talcott, Chas. L.* *L* | Russia | Herkimer. |
| " | Thomas, E. T. (agent).* *L* | Trenton | Oneida |
| Ravena | Day, Abraham | Coeymans | Albany. |
| Redwood | McDonald, Felix | Alexandria | Jefferson. |
| " | McDonald, John | " | " |
| Rochester | Hurd Lime Kiln | Rochester | Monroe. |
| " | May, Mr | " | " |
| " | Nellis, J. H.* *L* | " | " |
| " | Neuman, R. G.* *L* | Gates | " |
| " | Snow, John, estate | " | " |

| | | | |
|---|---|---|---|
| Rockton | Austin, C. D | Amsterdam | Montgomery. |
| Rondout | Lawrence Cement Co.* *C* | Kingston | Ulster. |
| " | New York & Rosendale Cement Co.* *C.* | Rosendale | " |
| Rossie | O'Brien, John.* *L* | Rossie | St. Lawrence. |
| Saratoga Springs | Leonard, Patrick | Milton | Saratoga. |
| " | Wing's, Prince, estate.* *L* | " | " |
| Schoharie | Brown, Albert.† *C* | Schoharie | Schoharie. |
| Seneca Falls | Fisher, John.* *L* | Fayette | Seneca. |
| Sharon Springs | Smith, Henry S.* *L* | Sharon | Schoharie. |
| Shelby | Simonds, E. B.† *L* | Shelby | Orleans. |
| Sing Sing | Sing Sing Lime Co | Ossining | Westchester. |
| Smith's Basin | Keenan Lime Co.* *L* | Kingsbury | Washington. |
| " | Nichols, D. & Son.* *L* | Hartford | " |
| Sodus | Horton, Mr | Sodus | Wayne. |
| Sodus Center | Mather, E. B. & Co.* *L* | " | " |
| " | Munn, Gardner A.* *L* | " | " |
| South Greenfield | Wing, Elihu.* *L* | Milton | Saratoga. |
| St. Johnsville | Smith, Albert H.* *L* | St. Johnsville | Montgomery. |
| Stone Ridge | Bastere, John | Marbletown | Ulster |
| " | Davenport, Solomon | " | " |
| " | Sahler, James D | " | " |
| Syracuse | Alvord, A. E.* *L. & C.* | Manlius | Onondaga. |
| " | Britton & Clark.* *L* | Onondaga | " |
| " | Solvay Process Co.* *L* | " | " |
| Thurso | Miller, Tob & Son | Clayton | Jefferson. |
| Troy | Cheney, W. E. & Son.* *L* | Smith's Basin | Washington. |
| Union Springs | Shalebo, J. L.† | Springport | Cayuga. |
| Upper Jay | Fuller, H. C | Jay | Essex. |
| Valley Mills | Dexter, C. W | Stockbridge | Madison. |
| Walworth | Hall, W. L | Walworth | Wayne. |
| " | Mann, Owen.* *L* | " | " |

DIRECTORY OF PRODUCERS OF LIME AND CEMENT — (*Continued*).

| Post-office. | NAME. | LOCATION OF QUARRY. | |
|---|---|---|---|
| | | Town. | County, |
| Walworth | Read, John.* *L* | Walworth | Wayne. |
| Warners | Empire Portland Cement Co.* *C* | Camillus | Onondaga. |
| Watertown | Cory, Henry S.* *L* | LeRay | Jefferson. |
| Wawarsing | Hornbeck, Chas. H | Wawarsing | Ulster. |
| Webster | Hanson, Wm | Webster | Monroe. |
| West Walworth | Wooster, Hiram O | Walworth | Wayne. |
| West Winfield | Bradley, A. P.* *L* | Winfield | Herkimer. |
| Whitfield | Barley, Albert.* *L* | Rochester | Ulster. |
| " | Dixon, Benj. C.* *L* | " | " |
| Wolcott | Post, Alonzo.† *L* | Butler | Wayne. |
| " | Walker, Chas. J.† *L* | " | " |
| Wolcottsville | Luckman, Wm. J.* *L* | Royalton | Niagara. |

# Millstones.

Millstones for grinding paint, feed, cement and other purposes are quarried from the Oneida conglomerate in Ulster county in the townships of Rochester and Wawarsing. The demand is said to be increasing yearly and during 1894 is said to have amounted to about $100,000.

The following is a list of the parties now quarrying millstones in this region:

## DIRECTORY OF PRODUCERS OF MILLSTONES.

* Parties producing in 1894.

| Post-office. | NAME. | Location of Quarry. | |
|---|---|---|---|
| | | Town. | County. |
| Accord ..... | Brodhead & Roosa* ..... | Rochester .. | Ulster. |
| " ..... | Rose, W. H.* ..... | " .. | " |
| Granite ..... | Van Etten, James S.* ..... | " .. | " |
| Kerhonkson ..... | Davis, J. P.* ..... | Wawarsing. | " |
| " ..... | Van Dover, William ..... | " . | " |
| Kyserike ..... | Harnden, T. C.* ..... | Rochester .. | " |
| " ..... | Krom, William H ..... | " .. | " |
| " ..... | Lawrence, Daniel ..... | " .. | " |
| " ..... | Lawrence, George ..... | " .. | " |

# Marl.

This material is found in many places throughout the State. Dutchess, Columbia, Orange, Ulster, Greene and Albany counties have many small deposits; in central and western New York there are large deposits in Onondaga and Madison counties, particularly in the Cowaselon swamp; it is also found in Cayuga, Wayne, Seneca, Ontario, Monroe, Genesee and Niagara counties.

It is a deposit formed in standing water and consists chiefly of carbonate of lime. It is largely used as a fertilizer, but is also employed in the manufacture of Portland cement as at Warners, Onondaga county, by the Empire Portland Cement Co., at Montezuma and at Wayland, Steuben county, by Millen & Co.

# Iron Ores.

The iron ores of New York have been carefully studied and described by Prof. J. C. Smock, who has published his results in Bulletin No. 7 of the New York State Museum and by Mr. Bayard F. Putnam who contributed an article on this subject to the volume on Mining Industries (No. XV) in the report of the Tenth Census. These two important papers taken together give a most complete review of the sources of iron in New York. Our knowledge of the Adirondack ores is supplemented by the work of Prof. J. F. Kemp, which is contained in Bulletin No. 13 of the New York State Museum, entitled the Geology of Moriah and Westport townships. The localities of all the principal mines are shown on the economic map. The following is a brief extract from Prof. Smock's bulletin.

# IRON ORES OF NEW YORK.

By JOHN C. SMOCK, revised by F. J. H. MERRILL.

The ores of iron, which occur in beds and deposits of workable size in the State of New York, may be classified, according to their chemical composition, into oxides and carbonates of iron, and these classes may be subdivided, following the mineralogical characters, into the several species and varieties. The following tabular arrangement shows the natural grouping of species in these two great divisions:

| Chemical Groups. | | Mineralogical Species and Common Names. | |
|---|---|---|---|
| Oxides | Anhydrous Ferric Oxide. Sesquioxide of iron. | Hematite | Red Hematite. |
| | | | Specular Ore. |
| | | | Clinton Ore.— Fossil ore. |
| | | | Red Ochre. |
| | Ferric and Ferrous Oxides. Proto-sesquioxide of iron. | Magnetite | Magnetic Iron Ore. |
| | | | Titaniferous Iron Ore. |
| | Hydrated Ferric Oxide. Sesquioxide of iron. | Limonite | Brown Hematite. |
| | | | Brown Ochre. |
| | | | Bog Iron Ore. |
| Carbonates | Ferrous Carbonate. Carbonate of Iron. | Siderite | Carbonate Ore. |
| | | Spathic Iron ore | Clay Iron Stone. |
| | | | "White Horse." |

A general law of occurrence of iron ores is that certain ore species occur in, or are characteristic of, definite geological horizons. For example, the magnetic iron ores are found in the crystalline rock areas of the Precambrian; the red hematite appears to mark the Huronian; the fossil ore, the limonite or brown hematite are found in the Palæozoic rocks; and the carbonate and the bog iron ore in the more recent formations of Tertiary and Post Tertiary ages. There are, as might be expected, many exceptions; but in the greater number of these apparently exceptional cases, the surface alteration, due to weathering or other atmospheric agencies, explains the occurrence.

This relation between the geological formation and the mineralogical species or *kinds* of iron ore indicates the areas in which they may occur, and determines roughly their limits. Hence, a geological map of the State shows approximately correct

boundaries of the several iron-ore districts, and is, as it were, an iron mines map. The geology of a county or district gives the clue in searching for ore; and its importance can not be too strongly stated, both as a guide, suggesting exploration, and warning against unnecessary and fruitless surveys and wasteful outlays of time and money. Thus, for example, the magnetites belong in the crystalline rock districts, and the search for them in the later, sedimentary rocks of the adjacent territory would be a hopeless task; or, again, the exploration of the Highlands or Adirondacks, for carbonate ores, would be equally unscientific and destitute of good results.

The geological formations, which are characterized as definite ore horizons, become the basis of a natural arrangement of the ore districts of the State. They are well marked geographically also.

Following this geologico-geographical arrangement, the groups and iron-ore districts are:

I. The Highlands of the Hudson.— Magnetic Iron Ores.
II. The Adirondack Region, Including the Lake Champlain Mine.— Magnetic Iron Ores.
III. The Hematites of Jefferson and St. Lawrence Counties.
IV. The Clinton or Fossil Ores.
V. The Limonites of Dutchess and Columbia Counties.
VI. The Limonites of Staten Island.
VII. The Carbonate Ores of the Hudson River.

A few isolated mines can not be thus classified, as the hematite near Canterbury, Orange county, Ackerman's mine near Unionville, Westchester county, the Napanock and Wawarsing mines, in Ulster county, the hematite of Mt Defiance in Ticonderoga, and the bog iron ores, which are scattered in all of the great divisions of the State. The iron sands of the shores of Long Island are left out, as not properly a natural source of iron.

### I. The Highlands of the Hudson. — Magnetic Iron Ores.

Magnetite is one of the common minerals in the crystalline rock region of the Highlands. It occurs as an accessory constituent in the granitic and gneissic strata; and by itself, forms

beds of considerable extent and thickness. Accordingly as it is more or less free from foreign minerals it is rich or lean, varying from the pure magnetic iron ore to rock with traces only of iron in its mineralogical composition. The beds of ore show lamination and are faulted, folded and contorted as the inclosing strata of rock, and have the same general strike and dip in common with the latter. They are generally of irregular form, in places widening into thick deposits or lenticular shaped masses, in others contracted in thin sheets, which are not mined profitably. The ore is found in some cases to separate into thin layers, and masses of rock ("horses") are met with entirely surrounded by the ore. The phases of variation are as many almost as there are mines, where they can be studied. In the larger and older mines the ore has been followed for thousands of feet in the line of strike or on the course of the ore, and for hundreds of feet in depth (on the line of dip) without reaching its limits. Owing to the unprofitable nature of working so thin ore beds, they are often not followed to the end, and the real extent of few of these ore deposits is known. In general, it may be stated that in this region the ore beds stand nearly on edge and have a northeast and southwest strike and a descent or dip at a steep angle to the southeast. In consequence of their highly inclined position and their irregular shape these ore bodies are called "veins," less frequently "chimneys" and "shoots" of ore.

The magnetic iron ore has not been found distributed uniformly throughout the Highlands. There appear to be certain ore *ranges* or belts in which the larger and more productive mines are opened. There are mine groups also, as the Sterling Iron and Railway Company's mines, the Greenwood mines, in Orange county; the Todd-Croft and Sunk mines, and the Croton-Brewster ranges in Putnam county. The boundaries of these ore-bearing belts and the intermediate barren territory have not been determined, since the exploration has been largely made by individual effort and without any general plan covering the whole area. It is probable that a geological survey of the Highlands would enable us to trace the limits of an iron-bearing group, as has been indicated by the surveys of the New Jersey Highlands.*

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* See "Ann. Report of the State Geologist for the year 1886." Trenton, 1887, pp. 82–85.

Mines have been opened in Orange, Rockland, Westchester and Putnam counties in this iron ore district and from the New Jersey line at the southwest to the Connecticut boundary on the east. Their locations are shown on the map which accompanies this report. Some of the largest and most productive mines in Orange county have been worked more than a century.* This county was famous for its iron manufacture during the Revolutionary war.† The greatest development of the iron mines in Putnam county has been since the opening of the Tilly Foster and Mahopac mines or during the last twenty-five years. The distance from public lines of transportation, the increased cost of working the smaller "veins" at greater depths, the low prices for iron ore and the competition with the richer ores of other parts of our country have necessitated the suspension of work in some of the mines and led to the permanent abandonment of those most unfavorably situated. Of the 40 separate mines, which have been ore producers, 10 only were in operation during a part or the whole of the year 1888. Their aggregate output for that year amounted to 114,000 gross tons. The ores of the Highlands district are the hard, crystalline magnetites. They are generally rich, free from titanium, but contain a slight excess of phosphorus above the limit for the manufacture of Bessemer iron, excepting the Mahopac and Tilly Foster mines, which have yielded a large amount of Bessemer ore, and a few small mines, but which are no longer worked.

## II. The Adirondack Region, Including the Lake Champlain Mines.— Magnetic Iron Ores.

The Adirondack region, the great mountain plateau of northern New York, is bounded by the valleys of Lake Champlain on the east, of the St. Lawrence river on the north and northwest, of Black river on the west, and the Mohawk on the south. It occupies nearly all of Warren, Hamilton and Essex counties, the western and southern parts of Clinton, the southern parts of Franklin and St. Lawrence, the eastern part of Jefferson and Lewis, the northern towns of Oneida, Herkimer, Hamilton and

* Ore was discovered on the Sterl ng tract as early as 1750; the Forest of Dean mine was pened about the same time.

† See "History of the Manufacture of Iron in all ages," by James M. Swank, Philadelphia, 1884, pp. 102-106.

Saratoga, and the northwest corner of Washington counties. Its area has been estimated to be at least 10,000 square miles. Dr. Emmons, in his survey of the Second Geological District, decribed the rock formation of this territory as gneisses and hypersthene rock principally; and the former he regarded as the prevailing rock, excepting in a large triangular area in Essex county, where the outcropping rocks are hypersthene.*

The so-called "hypersthene rocks" of Dr. Emmons consist of labradorite and pyroxene or labradorite with hypersthene and some pyroxene, and hence are often designated as a Labrador series. In an article on the "Laurentian Magnetic Iron Ore Deposits in Northern New York," Charles E. Hall has grouped the magnetites in three series, or horizons; the lowest, the Laurentian magnetites; second, the Laurentian sulphurous ores; and highest, the Labrador group with its titaniferous ores.†

Magnetite is one of the common minerals in the Adirondacks, and is widely distributed, both as a constituent or accessory mineral in rocks, and in beds of workable extent. Mines have been opened in all parts of the region, but the greatest development has been in the valley of Lake Champlain, and hence the ores are known in the market as Lake Champlain ores. In it are the famous Port Henry mines and others. The Chateaugay range can not be said to lie in the Champlain valley. Therefore the grouping by geological rather than by geographical lines alone, is more definite, and the larger district of the Adirondacks is better than any subdivisions according to our present knowledge. It is a notable fact that nearly all of the mines are on the borders, and that comparatively few ore localities have been found in the interior of it. A reference to the map of the State, with this report, shows the location of the mines and mine groups. The explanation of their distribution is the greater accessibility of the outer part of the region to lines of transportation and its more thorough exploration. Prospecting for iron ore in the forested and more distant interior is difficult, and besides, is not stimulated by any hope of adequate return, excepting in case of large deposits which, from their extent and character of ore, might warrant the construction of branch railway lines, as at Chateaugay, Clifton, Jay-

* Emmons: Survey of the Second Geological District, Albany, 1842, pp. 27–33 and 75–78.
† Thirty-second Annnal Report, N. Y. State Museum, pp. 133–140.

ville and Little River. Future explorations will, doubtless, discover many iron-ore beds, and result in the devolopment of other mining centers in what now appears as barren ore territory. The construction of additional railways, affording facilities for reaching the markets, will do much to open and develop new mines.

The titaniferous nature of the magnetites, which have been found in the Labrador series, as for example, at Splitrock, in Westport, and at Adirondack, in the town of Newcomb, Essex county, has retarded mining in the localities where they occur.

The difficulty and expense of reducing the ores containing considerable titanium, and the failures in the way of practically separating the titanic minerals from the magnetite, have shut them out of the iron ore market, and the mines having such ores only have been idle for years. That all the magnetic iron ore occurring in this geological horizon is alike titaniferous does not appear to be proven by the comparatively few ores analyzed from limited areas; and there is hope that ores sufficiently low in titanium for successful working may be found.*

The strike or course of the iron ore beds in so large a district is affected by all the local variations in the positions of the inclosing strata. In general, the direction is northeast and southwest. The dip is also at all angles, varying from a horizontal to a vertical Much further study of the geological structure is needed to explain the features which the mines have exposed to view. The immense deposits at Port Henry mines, the many separate beds of the Crown Point mines, the dikes and faults at Palmer Hill, the parellel shoots of the Arnold Hill mine, the bends and faults at Chateaugay are interesting features for study.

The magnetite, as it occurs in the Adirondack region, varies much in the degree of crystallization, in texture and color. In the Port Henry mines it is, as a rule, rather coarsely crystalline and lustrous black. At Palmer Hill and at Arnold Hill martite a hematite crystallizing as magnetite, appears to replace the latter mineral. The titaniferous ores are noted for their hardness, dull black fracture surfaces and general fineness of grain. In the nature of the associated minerals also, there is much variation. The more commonly occurring rock constituents are found everywhere. Apatite, also, is a common associate, as in some

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* Mr. James McNaughton of Albany, one of the owners of the McIntye tract, reports (Sept., 1895) that he has succeeded in smelting the titaniferous ores hitherto regarded as useless.

of the ore at the Port Henry mines. In general, the iron ores of this region average high in the percentage of metallic iron, especially the non-Bessemer ores; and on account of their richness, the Port Henry magnetites are widely known and esteemed. Bessemer ores are obtained in quantity at Crown Point, in the western range at Mineville (Port Henry), at Chateaugay, and at other localities, given in the notes of mines, further on in this report.

The beginnings of iron-ore mining in the Lake Champlain valley were early in the present century. Some of the forges were in operation in 1801 and 1802, and they were run upon the ores in their vicinity.* But the output was small, in the aggregate a few thousands of tons. The rapid increase was after 1840. In 1868 the town of Moriah, Essex county, produced 230,000 tons. The tenth census reported 742,865 tons from all of the mines in the Adirondack region. In 1888 the output was 182,000 gross tons, of which 418,000 tons came from the Port Henry mines. In the course of the last 10 years a notable change has been in the suspension of work at the mines which supplied the ores for the forges, or bloomaries. All of the bloomaries are idle, excepting those belonging to the J. & J. Rogers Iron Company and the Chateaugay Ore and Iron Company. The mines away from railway or lake navigation lines have all been closed. The capacity of production in the few mines which are in operation has been increased greatly by their better equipment and improved facilities for sending their ores to market. Another characteristic of the region is the great size of some of the ore beds. The great sheet, as it were, opened in the Chateaugay slopes, the thick beds or shoots of ore at Mineville (Port Henry), the great outcrops at Adirondack and the ridge of lean ore at Little River, are almost inexhaustible, and, with the advent of practicable, concentrating processes, all of them can produce cheap ores and compete with other iron-ore districts of the country.

The following chapter by Prof. J. F. Kemp gives the latest information on the titaniferous magnetites near Lake Sandford and Lake Henderson:

These great ore-bodies have claims to general interest, not alone from their size and geological relations, but also because they

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* SWANK: "History of the Manufacture of Iron in All Ages," Philadelphia, 1888, p. 106.

were the basis of an iron industry that was begun about 1840 and continued until 1858. They are situated near and on both sides of Lakes Sandford and Henderson, at the headwaters of the Hudson river, in Newcomb township, Essex county. They lie well within the great Norian area of the Adirondacks, Mt. Marcy being nearly due east eight or ten miles, Mt. McIntyre six miles northeast and the Indian Pass due north. Santanoni lies west and other minor peaks are near. Crystalline limestone outcrops about five miles southwest on Lake Newcomb. The country rock at most of the ore-bodies is the coarsely crystalline, dark blue labradorite rock or "anorthosite," characteristic of the Adirondacks. At the Millpond opening, where the walls are well exposed, it is perfectly massive and shows none of the crushing that is so marked a feature of the usual outcrops. Elsewhere garnets are sometimes met and a very little hypersthene. At the Cheney opening the walls, called "sienite" by Emmons, are a gneissoid gabbro. The greatest ore-body of all is the Sandford. This is exposed in a hillside a mile west of Lake Sandford, where an open cut shows a breast of about 20 feet of dense, black magnetite, with no walls apparent. A strong belt of attraction has been traced from this point to and across Lake Sandford. Emmons describes in his Report on the Second District, 1842 (p. 249), several sections across this bed that were exposed by costeaning ditches. They showed a maximum of over 600 feet of ore and wet in streaks. The trenches have been filled up since then and at present only the open cut referred to above is exposed. The ore contains crystals of labradorite with reaction rims of brown hornblende and biotite between them and the ore itself. The analyses afford from 51.44 per cent. to 63.45 per cent. iron and 18.70 to 10.91 $SiO_2$. It does not appear that Emmons, in his early explorations, knew that the ore contained titanium, nor that the operators of the furnaces in those early days of iron smelting were aware of its presence.

Two miles west of Lake Henderson is the Cheney ore-body, said to show 40 feet clear ore without walls appearing. It is somewhat sulphurous, a very exceptional property in the case of titaniferous ores. On both sides of the Adirondack river that connects Lake Sandford and Lake Henderson, and in the bed of the river itself, there are several ore-bodies. The one called the

Millpond is the largest, with about 12 feet of solid ore, that was mined to a considerable extent in the early days. It really appears to be one streak in a large belt. Analyses have yielded over 60 per cent. iron.

There are several important belts of attraction in addition to this and other outcrops that have not been much, if at all, opened up. One has been also found on the west shore of Lake Henderson, and float has been noted off to the northwest near the Preston ponds. In addition to these, a number of belts have been shown by the dipping needle back in the hills and also further south near the lower works, now called Tahawus.

Several experimental runs have been made with these ores to test whether the generally prevalent prejudice against titaniferous magnetite was well based or not. The results of the first series have been set forth by Mr. August Rossi in the Trans. Amer. Institute Mining Engineers, vol. xxi (pp. 832–867), 1893. The past spring a more extended run in a small blast furnace of about 20 feet in height was made at Buffalo on 150 tons of ore. By calculating the slag on the composition of titanite or sphene, or, rather, some of its allied minerals, and allowing $TiO_2$ to replace $SiO_2$ up to 42 per cent., no difficulty was experienced and an iron of very superior properties for car wheels and chilled castings was produced. Mr. Rossi, who conducted the run, is intending to describe it at length at an early date.

### III. Hematite Ores of St. Lawrence and Jefferson Counties.

The hematites, or red hematites, as distinguished from the brown hematites (limonites) are mined in a narrow belt, scarcely 30 miles long, stretching from Philadelphia, in Jefferson county, northeast into Hermon, in St. Lawrence county. The ore deposits are found associated with a so-called *serpentine* rock, and lying between the Potsdam sandstone and the crystalline rocks of the Archæan age. The geological horizon appears to be below the Potsdam, and it is probably Huronian, although it has not been so recognized by Dr. T. S. Hunt in his references to* the hematites of Canada and northern New York. The deposits are found to be very irregular in shape, due apparently to the

* "On the Mineralogy of the Laurentian Limestones of North America," in the 21st Ann. Report of the Regents of the University of New York, Albany, 1871, pp. 88-89.

way in which the "serpentine" rock is mixed with the hematite, but their general structure is that of stratified bodies. The cap rock is a sandstone; the bottom rock, slaty beds, underlain by a white, graphitic, crystalline limestone. From the variations in the ore, as tested by borings with the diamond drill at the Caledonia mines, it seems reasonable to assume the existence of two classes of deposits — one, the originally stratified sheets, and the other, secondary deposits in smaller and irregular shaped pockets.

The hematite of these mines is generally firm and massive, of a deep red color, soiling whatever it touches. In some of the mines there is a specular ore, which has a crystalline structure, metallic lustre and is of a steel-gray to black color. Calcite, carbonate of iron, ferruginous quartz, pyrite and millerite occur in the ore. These ores average from 48 to 53 per cent. of metallic iron. They contain an excess of phosphorus above the limit demanded by furnace managers for making Bessemer iron. For mixing with more refractory ores they are sought after, being almost self-fluxing. In the market they are often known as "Antwerp red hematites" and "Rossie hematites."

Charcoal furnaces were built early in this century at Rossie, St. Lawrence county, and at Sterlingville and Antwerp, in Jefferson county, for smelting these ores. Of the older mines the Shirtliff and Tate and Polly have been abandoned. Two new mines have become producers, the Clark and Pike. The total production of the district was 110,000 gross tons in 1888.

## IV. The Clinton or Fossil Ores.

The red hematite of the Clinton group bears several names; thus: From its aggregated grains it is termed "oolitic ore" or "lenticular iron ore;" from its fossiliferous character, it is widely known as "fossil ore," and from its place in the geological series, it is often called "Clinton ore." It is remarkable for the thin, yet persistent beds over wide areas, which lie between green shales and calcareous strata. Following the outcrop of the Clinton group, the ore has been found in Herkimer, Oneida, Madison, Cayuga, Wayne, and Monroe counties. West

of the Genesee river Prof. Hall reports that it was not seen.* There are two beds, generally about 20 feet apart, according to Vanuxem's report on the Clinton group, thin, averaging little more than a foot, and distinguished by more abundant oolitic particles in the lower bed and by the larger grains and concretions in the upper bed.† Very little mining has been done, excepting in the towns of Clinton, Oneida county, and Ontario, in Wayne county. The average thickness of the beds in these mines is 30 inches, and one bed only is worked. They lie almost horizontal, dipping slightly to the south; and in the extraction of the ore a part of the overlying shales has to be removed and the roof supported by timbering.

The ore consists of lenticular-shaped grains, closely aggregated in a firm solid mass, which has to be broken up by blasting and heavy sledging. It is more friable and soft on the outcrop. It is brownish red in color and soils like a paint. The percentage of metallic iron varies less than in the magnetic iron ores and in the brown hematites. The average is 44 to 48 per cent. The phosphorus is above the Bessemer limit. It is well adapted for making foundry iron and is used for that class of iron mainly. Local furnaces take nearly all the output of the mines. The first lease for digging Clinton ore was given in 1797.‡ The last United States census reported the total production to be 85,442 gross tons of ore. In 1888 it amounted to 75,000 tons.

### V. The Limonites of Dutchess and Columbia Counties.

The ore deposits and mines, as here grouped, are in two principal ranges and limestone valleys. First, Fishkill-Clove belt, stretching northeast, from the Highlands of the Hudson, across the towns of Fishkill, East Fishkill, Beekman and Unionvale; second, the north-south valley, traversed by the New York and Harlem railway, from the Highlands across Dutchess county, and to Hillsdale in Columbia county. The limonite, or brown hematite ore, is found in small pockets of irregular shape, and also in large deposits, which are associated with ochreous clays, and in some

* See Prof. Hall's report on "Survey of the Fourth Geological District," Albany, 1843, p. 61.

† Vanuxem's report on "Survey of the Third Geological District," Albany, 1842, p. 83.

‡ BIRKINBINE; "The iron ores east of the Mississippi River," in Mineral Resources of the United States for the calendar year 1886, p. 50.

cases, with a gray carbonate of iron, in beds underlying it. These ore bodies are wholly in the limestone or between the limestone and the adjacent slate or schist formations, or they are in the latter, and as a rule of occurrence they are found on or near the dividing line between these formations. Near Fishkill and at Shenandoah the deposits are at the border of the Potsdam sandstone and at the foot of the Archæan ridges. The existence of the carbonate ore in the deeper parts of some of the mines and interstratified with the limestones is suggestive of the origin of the oxide (limonite) by the decomposition of the ferriferous beds through oxidation and the agency of carbonated waters, and of the great masses of colored clays, also, through the disintegration and decay of the slaty rocks and more argillaceous limestone.* The limestone of these valleys and these overlying slaty rocks have been studied by Prof. Dana, and are referred by him to the Trenton limestone and the Hudson river slate formations.†

The ore occurs (1) in large masses, somewhat cellular, having the interstices filled with clays or sandy earths, (2) in cavernous and hollow "bombs," often with beautiful mammillary or stalactitic incrustations on the interior, and (3) in irregularly shaped, fragmentary masses, distributed unevenly through the ochreous clays ("ochres") and sandy earths. The more solid ore has to be broken down by blasting; in the more earthy parts of the deposit it can be picked down and nearly all of the ore be sorted by hand. In mining, pits are sunk and worked open, or drifts are cut from the pit, horizontally into the ore, and much of it is won by underground work. In this district nearly all of the ore is mined from open pits; and some of them have reached vertical depths of over 100 feet. The ore is commercially known as "rock ore" or "lump ore," that which is sorted by hand, and "wash ore," which is the residue after the earths and sands have been removed by washing. The brown hematite ores of Dutchess and Columbia counties vary considerably in their chemical composition, all containing more or less silica, little or no sulphur, but are rarely low enough in phosphorus to answer for Bessemer pig-iron manufacture. Although there have been many ore localities dis-

* For a clear and concise statement of the origin of these ores see "Note on the making of Limonite ore beds," by PROF. JAMES D. DANA, in Am. Jour. of Science (3), vol. XXVIII, pp. 398-400.

† Am. Jour. Science (3), vol. XVII, pp. 375-388 and vol. XXIX, pp. 205 *et seq.*

covered in these counties, 24 only have been developed into working mines, deserving of enumeration in this report.

The earliest iron manufacture in the State was in Columbia county, on Ancram creek, and was probably on these ores. The Salisbury mines in Connecticut, properly a part of this iron-ore district, were opened more than 150 years ago. The causes which have operated in the Highlands have been effective here also in closing many of the mines, so that, in 1888, there were but nine at work, and four of them were closed during the year. The aggregate output has declined from 144,878 gross tons for the census year, 1879–80, to 43,000 tons in 1888.

### VI. The Limonites of Staten Island.

The group of iron mines on Staten Island are in a superficial deposit probably derived from the underlying rock in the process of decomposition which has produced the serpentine of that region.

### VII. The Carbonate Ores of the Hudson River.

The mines of spathic iron ore, or carbonate ore, are in the valley of the Hudson river, in Columbia county, south of the city of Hudson, and in Ulster county near Napanock. The mines south of Hudson are known as the Burden iron mines; and, on account of their extent and productiveness, and the comparative insignificance of the Ulster county mines, they may be considered as practically the whole of this group. The range in which the Burden mines are opened is between one and two and a-half miles east of the river, opposite Catskill, and is four miles in length, from north to south It lies partly in the town of Greenport and partly in Livingston. The ore crops out in the western face and near the crest of Plass Hill at the north, and in Cedar Hill and Mount Thomas at the south. It is stratified, and its bed dips at angles of 20° to 40° to the east. South of Mount Thomas and in mine No. 2, at Burden, a synclinal fold has been mined out. The thickness of the ore varies considerably, and for the greater part of the distance the average is from 10 to 20 feet. In the Burden mines as much as 30 feet of ore has been found; in mine No. 2 and in Mount Thomas upwards of 45 feet. The underlying beds are shaly and are probably of the Hudson river slate formation. Above the ore there is a silicious conglomerate, which is suc-

ceeded by a shale, and that by a gray sandstone, and that, in turn, by a calcareous conglomerate.

The ore varies in composition from a silicious and lean ore at the north, which contains generally too much phosphorus for making Bessemer pig-iron, to a rich, Bessemer ore at the south. Quartz in fine grains, calcite in small, crystalline nests and pyrite are common in it. All of it has to be roasted before smelting. The Burden mines are reached by a railway three and a-half miles long, from the Hudson river, near Catskill station.

The first mining of considerable extent done on this range was in 1874. Next year the Hudson River Spathic Iron Ore Company was organized, and the mines were worked by that company for about two years. In 1882 the property came into the possession of the Hudson River Ore and Iron Company, and a large establishment was at once set up. There are 10 roasting kilns on the river at the Burden docks; and the ore is shipped to Troy, Scranton, Pa., and Franklin Furnace, New Jersey.

## LOCALITIES OF IRON ORE IN NEW YORK.

*Magnetite.*— There are two principal districts of this ore: (1) Highlands or southeastern, (2) Adirondack or northern. In the first there are mines at Sterling, near Greenwood, and Forest of Dean, besides many smaller mines in Orange county. There are numerous openings in northern Westchester and southwestern and central Putnam counties, east of the Hudson river (Croft's, Mahopac, Theall, Tilly Foster, etc.). In northern New York ore occurs at many localities in Washington, Saratoga, Warren, Essex, Clinton, Franklin, St. Lawrence, Lewis, Herkimer and Fulton counties. Mines are worked at Mount Hope in Washington county, near Crown Point; Paradox lake, in vicinity of Port Henry in Essex county, and very large deposits unworked occur at Adirondack and in Westport; Palmer Hill, Arnold ore bed, and Chateaugay in Clinton county; Clifton (idle), in St. Lawrence county; occurrences are also noted in Jefferson county.

Magnetic iron sand is found to some extent on the southern shore of Long Island, on the western shore of Lake Champlain and on the Hudson river and smaller streams in the northern part of the State.

An aluminous magnetic ore occurs near Peekskill, Westchester county; it is self-fluxing, but not now worked except for emery, though it occurs in large deposits.

*Hematite specular iron ore, red hematite.*— Gouverneur, Fullerville, St. Lawrence county; Philadelphia and Antwerp, Jefferson county, productive mines. It occurs in Hermon, Edwards, Fowler and Canton, in St. Lawrence county.

*Hematite fossil ore, lenticular clay iron ore.*— This ore has been worked chiefly at Verona, Westmoreland, New Hartford and Clinton, Oneida county; Ontario, Wayne county. It also occurs in Madison county in thin beds.

*Limonite, brown hematite.*— This ore occurs at East Fishkill, Sylvan lake, Beekman, Pawling, Dover, Unionvale, Amenia, Sharon, Millerton and Mount Riga, in Dutchess county; Copake, Ancram and Boston Corners, in Columbia county; the mines at these localities produce largely. Besides these are the Townsend mine, Cornwall, Orange county; Castleton Four Corners, New Dorp and Todt Hill, Staten Island.

*Limonite, bog iron ore.*— There are numerous localities and many small deposits of this ore in the northern and eastern parts of the State. It was formerly worked to a small extent, but is now abandoned.

*Siderite, spathic iron ore, carbonate of iron.*— Near Catskill Station and Linlithgo, Columbia county, an immense deposit has been developed; at Napanock, Ulster county, a deposit was formerly worked; in Dutchess county it occurs in small quantity; at Antwerp, Jefferson county, in crystals only.

# Mineral Paint.

The mineral paint of New York State is from comparatively few localities, and is manufactured from rocks of three different formations:

1. From Clinton iron ore.
2. From Cambrian red and green slate.
3. From Chemung shale.

No statistics of production are furnished by the manufacturers.

This material is produced as a by-product in several other industries. For instance near Whitehall red and green mineral paint are produced by grinding up the refuse of the slate mills. In Oneida county, paint is manufactured from the Clinton iron ore. At Randolph in Cattaraugus county, paint is made from red shales of the Chemung group. At Roxbury, Delaware county, paint is made from red Catskill shales and at Oneonta a similar pigment has been made.

## Directory of Mineral Paint Manufacturers.

(Metallic paint.)

| | |
|---|---|
| Clinton Metallic Paint Co | Clinton. |
| Rossie Iron Ore Paint Co | Ogdensburg. |
| Oneonta Mineral Paint Co | Oneonta. |
| Ontario Metallic Paint Co | Rochester. |
| Delaware Mining, Milling and Manufacturing Co., | Roxbury. |
| Wm. Connors (also slate) | Troy. |

*Ochre.*

| | |
|---|---|
| Bruno, Grosche & Co | New York. |

*Shale.*

| | |
|---|---|
| Elko Mineral Paint Co | Randolph. |

*Slate.*

| | |
|---|---|
| William Connors (also met. pt.) | Troy. |
| Francis Thomas | Troy. |
| Robert A. Hall | Whitehall. |

# Salt.

The salt industry of New York is of great importance. Originally Syracuse was the center of this industry, but since the discovery of rock salt in and near the Genesee valley from which richer brines can be obtained than at Syracuse, the center of the industry has been transferred to this new district and the manufacture of salt at Syracuse will gradually diminish.

The salt mines of the Retsof, Lehigh, Livonia and Greigsville companies produce immense quantities of salt for the beef and pork packing industries, and in this respect are not directly competitors of the companies manufacturing salt from brine. About 15 miles south of Syracuse the Solvay Process Company having found rock salt in great quantity, by boring a large number of wells and availing itself of an abundant water supply is, by the aid of gravity, enabled to bring to its works at Syracuse through a pipe line, brine in a highly saturated condition. This is the basis of a very large industry in soda ash. The salt of New York occurs wholly in the Salina group.

A detailed description of the salt and gypsum deposits of New York is given in Bulletin No. 11 of the New York State Museum by Frederick J. H. Merrill. From this publication the following sketch of the geology of salt in New York is abstracted :

## Geology of Salt in New York.

The salt of New York occurs almost exclusively in the Salina group or, as it is also called, the Onondaga salt group of the Upper Silurian period which was described by Vanuxem as follows : *

"This important group contains all the gypsum masses of western New York, and furnishes all the salt water of the salines of the counties of Onondaga and Cayuga. From the point where the Niagara group terminates at the east, it rests upon the Clinton group; and as the latter group also comes to its end near the first district, it reposes there upon the Frankfort slate, upon which it continues to near the Hudson river.

* Report on the Geology of the Third District of New York.

"It forms a part of the high range on the south side of the Mohawk; appearing at the north end of Otsego county, and in Herkimer and Oneida, being its northern outcrop. It makes its first appearance by the side of the Erie canal at the east end of Madison county, and thence west the canal was excavated in the group.

"The Onondaga salt group may be divided into four deposits. There are no well-defined lines of division between the deposits; but for practical purposes the divisions are sufficiently obvious.

"The first or lowest deposit is the red shale, showing green spots at the upper part of the mass. 2d. The lower gypseous shales, the lower part alternating with the red shale, which ceases with this mass. 3d. The gypseous deposit, which embraces the great masses quarried for plaster, consisting of two ranges, between which are the hopper-shaped cavities, the vermicular limerock of Eaton, and other porous rocks. 4th and lastly. Those rocks which show groups of needle-form cavities placed side by side, caused by the crystallization of sulphate of magnesia* and which may from that circumstance be called the magnesian deposit.

"The whole of these deposits are found between Oneida creek and Cayuga lake. To the east of the creek, they do not all occur, as will subsequently be made known. They thin out to the eastward and probably terminate entirely a few miles east of the Hudson river; from which point their thickness gradually increases toward the west, and reaches its maximum in the counties of Onondaga and Cayuga, where it is not less than 700 feet. The gypsum has not been seen east of the western part of Oneida county. The red shale comes to its end at the east end of Herkimer county; and the whole group is reduced, in the Helderberg in Albany county to a few feet of light-gray or lavender-colored compact calcareous rock with pyrites, separating the Frankfort portion of the Hudson River group from the water lime series."

The outcrop of the Salina shales is shown on the accompanying map.

The red shale is fine grained, earthy in fracture and without regular lines of division. It breaks or crumbles into irregular fragments. This deposit is not found east of Herkimer county

*Sulphate of lime most probably.

and varies in thickness from 100 to nearly 500 feet. The second member of the series consists of shale and calcareous rock of a light-green color intermingled with a red shale at its lower part. But little gypsum occurs in this member. The rock is extremely porous, easily penetrated by water and falls to pieces at once on exposure to the air. The third or gypseous deposit, which is important commercially on account of its plaster beds, is also the horizon from which the brine springs of Onondaga, Cayuga and Madison counties were supposed by Vanuxem to have been derived. The mass of the deposit consists of rather soft yellowish or brownish shale and slate, both argillaceous and calcareous. It may be called a gypseous marl. It falls to pieces when exposed to the weather, breaking in a series of joints nearly at right angles to each other which give the rock a rhombic cleavage. In the third district the gypsum of this horizon does not often occur in layers or veins, it usually occurs in isolated masses of irregular form. At many points there appear to be two ranges or levels of these plaster beds, as they are called, separated by shale containing hopper-shaped cavities. These cavities, which are from one to ten inches in diameter, are of much interest for they represent the external casts of salt crystals, which were probably formed during the evaporation of the water from the basin in which the Salina deposits were laid down. But few fossils are found in the Salina group, for at the time when the shale and gypsum were deposited the water contained too high a percentage of soluble salts to support animal life.

The fourth deposit was called the magnesian deposit on account of the assumption that the needle-like cavities were due to the crystallization of sulphate of magnesia. As needle-like crystals of sulphate of lime are well known, and as gypsum is abundant in this horizon, it seems more probable that these needle like crystals were crystals of gypsum.

Prof. James Hall* describes the Salina group as follows: Succeeding the Niagara group is an immense development of shales and marls with shaly limestones including veins and beds of gypsum. The general color is ashy approaching drab with some portions of dark bluish green. The lower part is of deep red with spots of green. Succeeding this, where protected from

* Geology of the Fourth District.

atmospheric influences, the rock is blue, like ordinary blue clays, with bands of red or brown. This portion and that succeeding it are often green and spotted, and contains seams of fibrous gypsum and small masses of reddish selenite and compact gypsum. From this it becomes gradually more gray with a thin stratum of clayey limestone, which is sometimes dark, though generally of the same color as the surrounding mass. The formation terminates upward with a gray or drab limestone called by Vanuxem the "magnesian deposit." The red shale forming the lower division of the group is well developed, but in the third district has not been found west of the Genesee river. It appears in the eastern part of Wayne county as indicated by the deep red color of the soil which overlies it.

At Lockville a greenish-blue and marl with bands of red has been quarried from the bed of the Erie canal. West of the Genesee this is the last of the visible mass. The red shale has either thinned out or lost itself, gradually becoming a bluish-green, while otherwise the lithological character remains the same. On first exposure it is compact and brittle, presenting an earthy fracture. But few days are necessary to commence the work of destruction, which goes on until the whole becomes a clayey mass. The prevailing features of the second division of the group are the green and ashy marl with seams of fibrous gypsum and red or transparent selenite often embracing nodules of compact gypsum. The third division comprises all the gypsum beds of the fourth district which are of economic importance. In this third division hopper-shapped cavities occur in Wayne and Monroe counties, but rarely in Genesee or Erie.

There is scarcely any well-defined division between the shales and shaly limestones of the third division and the so-called magnesian deposit which overlies it. This limestone in the western part of the State is used extensively for hydraulic cement and is now worked by the Cummings Cement Company of Akron and the Buffalo Cement Company.

In their studies of the Salina group, Professors Hall and Vanuxem found no rock-salt because this soluble mineral can not remain at the surface. However from various wells and shafts, sunk during the past 11 years, we have sections of the Salina group which show the position and relation of the salt beds.

## Producers of Salt in New York State.

### *Onondaga District.*

| | |
|---|---|
| C. & A. Stillwell * | Collamer, N. Y. |
| Geddes Coarse Salt Co | Geddes (via Syracuse), N. Y. |
| Highland Solar Salt Co.* | Liverpool, N. Y. |
| P. Corckings | Syracuse, N. Y. |
| T. K. Gale | " |
| M. Prell | " |
| American Dairy Salt Co.* | " |
| Highland Coarse Salt Co | " |
| Salina Coarse and Fine Salt Co | " |
| N. E. Loomis, executor | " |
| Turk's Island Coarse Salt Co | " |
| James M. Gere | " |
| William J. Kilian | " |
| John White & Co | " |
| P. Rogers & Co | " |
| M. R. Hayes | " |
| H. H. Freeman | " |
| Richard Farrell * | " |
| P. Prendergast | " |
| Salt Springs Solar Coarse Salt Co | " |
| W. B. Boyd | " |
| Syracuse Solar Salt Co.* | " |
| Foster, Ely | " |
| Cape Cod Coarse Salt Co | " |
| Empire Coarse Salt Co | " |
| Salina Coarse and Fine Salt Co | " |
| Western Coarse Salt Co | " |
| Theodore L. Poole | " |
| Draper & Porter | " |
| W. & D. Kirkpatrick | " |
| Union Coarse Salt Co | " |
| Robert Young | " |
| C. B. Murray | " |
| George Brown & Co | " |
| Andrew Martin | " |
| Edward Lynch | " |

* Idle in 1893.

| | |
|---|---|
| James Salmon | Syracuse, N. Y. |
| W. A. & J. B. Gere | " |
| A. L. Mason | " |
| Duncan W. Peck | " |
| Le Roy Salt Co | Le Roy, N. Y., 21 grainers, 13 wells. |
| Genesee Salt Co. (5 pans, 5 wells) | Mercantile Exchange, N. Y. |
| Pavilion Salt Co | Pavilion, N. Y. |
| Kerr Salt Co | Rock Glen, N. Y. |
| Duncan Salt Co | Silver Springs, N. Y. |
| Pearl Salt Co | Warsaw, N. Y. |
| W. C. Gouinlock | " |
| Empire Dairy Salt Co | " |
| Warsaw Salt Co | " |
| Crystal Salt Co | " |
| Hawley Salt Co | " |
| Bradley Salt Co | " |
| Miller Salt Co | " |

Rock Salt.

| | |
|---|---|
| Retsof Mining Co | Retsof, N. Y. |
| Livonia Salt and Mining Co | 115 Broadway, N. Y. city. |
| Lehigh Salt and Mining Co | Scranton, Pa. |
| Greigsville Salt Mining Co | Greigsville, N. Y. |
| Cayuga Lake Salt Co | Ludlowville, N. Y. |
| —— Hyman | Livonia Station, N. Y. |
| J. C. Reed | " |
| Glen Salt Co | Watkins, N. Y. |

# Gypsum.

Gypsum is quarried in New York on the outcrop of the Salina group in Madison, Onondaga, Cayuga, Ontario, Monroe and Genesee counties. It is chiefly used as a fertilizer in the form of land plaster, though at Oakfield, Genesee county, a factory has been established to utilize the gypsum in the manufacture of wall plaster.

# DIRECTORY OF PRODUCERS OF GYPSUM.

* Parties producing in 1894. † Parties producing previous to 1894 now idle.

| Post-office. | NAME. | Location of Quarry. | |
|---|---|---|---|
| | | Town. | County. |
| Cottons | Buttons, R. D.* | Sullivan | Madison. |
| Fayetteville | Condee, W. W.* | De Witt | Onondaga. |
| " | Edwards, A. W | " | " |
| " | Lansing, H H.* | " | " |
| " | Severance, F. M.* | " | " |
| " | Snook, Clark | " | " |
| " | Todd, R. J.* | Manlius | " |
| " | Wheeler, Horace.* | " | " |
| Garbutt | Garbutt, John W.* | Wheatland and Garbutt, | Monroe. |
| Half Way | Kenna & Allen † | Camillus | Onondaga. |
| Hobokenville | Tuttle, Irving * | Lenox | Madison. |
| Jamesville | Alvord, E. B. & Co.* | De Witt | Onondaga. |
| " | Dunlop, Robert & Co.* | " | " |
| Marcellus Falls | Sherman, J. N.* | Marcellus | " |
| Oakfield | Olmstead Stucco Company * | Oakfield | Genesee. |
| Perryville | Hodge, F. W.* | Sullivan | Madison. |
| " | Worlock, Cyrus.* | " | " |
| Phelps | Miller, A. D.* | Phelps | Ontario. |
| Port Gibson | Grinnell, Ezra * | Manchester | " |
| Syracuse | Alvord, A E.* | Onondaga | Onondaga. |
| Union Springs | Cayuga Plaster Company | Springport | Cayuga. |
| Victor | Conover, Theodore | Victor | Ontario. |

# Graphite.

Graphite of excellent quality is produced near Ticonderoga, the deposit being controlled by the Dixon Crucible Company of Jersey City. The mineral occurs in a mica schist and in crystalline limestone. It is used in the manufacture of pencils, crucibles, lubricant and a variety of other purposes.

# Quartz.

This material is quarried for pottery at Bedford, Westchester county, and is shipped to Trenton, N. J. White quartz of Potsdam age which is quarried at Fort Ann in Washington county, has been ground for use as a wood filler. It has also been used at the Troy Iron Works for lining Bessemer converters and similar refractory purposes.

# Glass Sand.

The two chief sources of this material in New York are Ellenville, Ulster county, and Durhamville, Oneida county. At the former locality the quarries are operated by the Crystal Sand Manufacturing Co. The sand is obtained from the Shawangunk grit, which is crushed to exceeding fineness. Much of the product is sent to the glass works at Corning.

Large glass sand deposits of Quaternary age occur at Durhamville near Oneida Lake. They are operated by William Williams. The sand is not as white nor as fine as that from Ellenville, and is used for the commoner grades of glassware. Much of it is shipped to Lockport. The sand contains 97–97.5 per cent. Si. 02.

# Molding Sand.

Sand for molding is found in Albany county immediately below the surface soil. When this is removed the sand is skimmed off to a depth of about six inches. It is quite extensively shipped from the town of Bethlehem. Near Poughkeepsie molding sand is obtained from a silicious limestone which, in decomposing, leaves a fine sand which has been found very satisfactory for this purpose.

# Garnet.

Garnet is mined or quarried in New York State in and near the valley of the upper Hudson river in Warren county on the borders of the Adirondack region. It all appears to be of the common variety, Almandite, and occurs in a formation of crystalline limestone which appears to form the bed-rock of the valley in the vicinity of North Creek and Minerva and in gneissic rocks which adjoin or are intercalated with the crystalline limestone. It is found in segregated masses of varying sizes from that of a pigeon's egg to a diameter of 20 feet. It is commercially classified as massive garnet, shell garnet and pocket garnet, the former being impure from the admixture of other minerals. The shell garnet is almost entirely pure and the most valuable for industrial purposes. The pocket garnet is that which occurs in small segregations or incipient crystals in the gneiss. Garnet is also found in Delaware county, Pa., where it is quarried under the name of "Rose" garnet by Herman Behr & Co., to the extent of about 1,000 tons annually. It occurs there in small crystals thickly disseminated through a quartzose gneiss. There is also a deposit of garnet at Chester, Pa., which is worked to

some extent. Large deposits of the mineral have been found in North Carolina, but its quality is not considered as satisfactory as that from the Adirondack region. Other deposits are said to occur in Georgia and Alaska, but no definite information can be obtained concerning them. Connecticut is also mentioned as a source of garnet.

This garnet is used almost exclusively in the manufacture of sandpaper, or garnet-paper, as it is called, which is employed extensively for abrasive purposes in the manufacture of boots and shoes. It is also employed to some extent in the wood manufacturing industry. For metals garnet is not as good as emery, although some satisfactory results have been obtained from its use on brass. It has been experimentally mixed with emery in the manufacture of emery-wheels but without very satisfactory results. The firms quarrying and using garnet from the Adirondack region are H. H. Barton & Co., of Philadelphia, who control very extensive deposits there; Baeder, Adamson & Co., of Philadelphia; Herman Behr & Co., of New York, who also are interested in the deposits in Delaware county, Pa.; Wiggins & Stevens of Boston, who are also interested in the deposit at Chester, Pa.; the Boston Flint-paper Co., and the Union Sandpaper Co., of Boston.

In commercial use garnet is found to be harder, sharper and more lasting than quartz and is preferred to it for certain kinds of work, although it costs about eight times as much as quartz. The Adirondack garnet is said to be worth about $40 a ton at the railroad, although the average value of the mineral throughout the country is stated to be about $35. The superiority of garnet to quartz is probably due to the fact of its ready cleavage, which enables it to present, as it breaks away, new and sharp cutting edges, whereas quartz, which has no cleavage, becomes dulled by friction. The only garnet now mined in the Adirondack region is the pocket garnet, which is used to make the better grade of garnet-paper. Some of the massive garnet has been used to make sandpaper for wood-working, and also mixed with corundum to make emery-wheels. The total production of Adirondack garnet in 1893 was about 520 tons, but this was much ess than th usual output owing to the general stagnation of business and the small demand for garnet-paper. For several

years previous to 1893 H. H. Barton & Co. are said to have mined from 800 to 1,000 tons per year. In 1893 the shipments from North Creek amounted to 1,475 tons. During 1894 almost nothing has been done in the mining of garnet. Only 294 tons were shipped from Warren county, New York. William Hooper & Sons of Ticonderoga have recently erected a mill near Minerva to crush the garnet-bearing rock and separate the garnet by water. This, if successful, will to some extent revolutionize the garnet business as many deposits not worth working by hand-sorting could be made to pay in this way.

## Emery.

Emery is quarried at many points in Cortlandt township, West chester County, from deposits which occur in the eruptive rocks known as the "Cortlandt series." It is used by the New York Emery Company at Peekskill.

## Diatomaceous Earth --- Infusorial Earth.

This material consists of hydrated silica, and is the accumulation of the minute skeletons of microscopic forms of vegetable life known as diatoms. It accumulates in the bottoms of ponds and lakes, and is found in recent as well as Tertiary and Cretaceous formations. While the living diatoms are found in all the waters of the State, deposits of diatomaceous earth have been reported from only two localities. One of these is in White lake, town of Wilmurt, Herkimer county, and the other is on the shore of Cold Spring Harbor, Long Island, on the property of Dr. Oliver Jones. The latter is a fossil deposit in beds probably of Tertiary age. The White lake deposit is the only one in use commercially at present. The material is dug from the bottom of the lake, which covers about four acres, and has a thickness of two to thirty feet, being covered by about four feet of water. It

is washed and run through strainers and pipes to settling vats, where it stands for twenty-four hours. The water is then drawn off and the material shoveled into the press. Here it is made into cakes four feet square and four inches thick. These are subdivided into cakes one foot square and piled under sheds to dry. For this information I am indebted to Mr. Thomas W. Grosvenor, of Herkimer, the proprietor.

The White lake material is at present only used for polishing, though similar material is used for absorbing nitroglycerine in the manufacture of dynamite.

The following analysis by Dr. Gideon E. Moore, of New York city, is furnished by Mr. Grosvenor:

| | |
|---|---|
| Water and volatile matter | 12.120 |
| Silica | 86.515 |
| Alumina | 0.449 |
| Ferric Oxide | 0.374 |
| Lime | 0.120 |
| Undetermined | 0.422 |
| | 100.000 |

## Talc.

This material occurs near Edwards, St. Lawrence county, N. Y., in a narrow belt several miles long and about a mile wide. There are several quarries on the line of this belt. It is ground in mills near Gouverneur under the control of the Asbestos Pulp Co. It is chiefly used in the manufacture of paper and a small quantity is used in soap, paint and other minor purposes. The annual product is about 30,000 tons, valued at about $240,000.

## Peat.

This material, which is the residue from the partial decay of plants in water, is of frequent occurrence but is only used locally as a fertilizer.

# Petroleum and Illuminating Gas.

The occurrence of petroleum in New York was first recorded by a Jesuit missionary who visited the oil spring at Cuba, Allegany county, in 1627. Late in the present century the oil from this spring was highly valued by the Indians for external applications and was thought to have a highly curative power. It was widely known under the name of "Seneca oil." The production of oil in New York is at present confined to Cattaraugus and Allegany counties. The Cattaraugus county field is a northward extension of the Bradford field of Pennsylvania and is continuous over the State line. The Allegany field is more isolated, although the oil comes from the same geological horizon. This has been discussed in great detail by Charles A. Ashburner in the Transactions of American Institute of Mining Engineers for 1887 and does not need detailed consideration here. Within a few weeks discoveries of oil are reported from Greig in Lewis county, but the value of the find is uncertain.

Natural illuminating gas was first used in New York at Fredonia, Chautauqua county, in 1821. This material is still in use at the locality in question. Besides Fredonia, at the present time Buffalo, Honeoye Falls, Pulaski and Sandy Creek are using natural gas for heating and illuminating purposes and a well is being bored in the vicinity of Oswego. Gas wells have been bored tentatively at a large number of places in New York State and small quantities of gas have been found, but the enterprises have not been financially successful. At present many of the wells in Buffalo have ceased to yield and a large quantity of the natural gas now consumed in that city is brought in pipe-lines from Canada.

On the economic map the oil pools are shown as mapped by C. A. Ashburner and corrected to 1893 by D. A. Van Ingen, who has written a brief sketch of the oil districts.

# PETROLEUM.

By D. A. VAN INGEN.

## Petroleum in New York State.

The oil territory in New York State is a continuation of the Bradford field of Pennsylvania. The counties of Cattaraugus and Allegany contain almost all the developed territory for oil. The first drilling was done at Limestone in Cattaraugus county in 1865, followed by wells at Petrolia and Richburg in Allegany county in 1881 and 1882, respectively. The oil sand is called the "Richburg" in Allegany county, and the "Bradford" in Cattaraugus county, but many claim them to be identical. The sandstone is a close, fine-grained rock of a dark-brown color. The general direction of the strata runs northeast and southwest, dipping to the southwest from three to twenty-five feet to the mile. In the southern part of Allegany county a fourth sand, known as the "Waugh and Porter" is drilled into. This lies some eighty feet below the "Richburg" sand and seems to be a different oil sand, although there is much difference of opinion with regard to it.

The oil varies in color from light yellow to almost black, although the dark-green oil is by far the most abundant. Its specific gravity at 10° C. runs from 38° to 45° B. Up to date about 8,000 wells have been drilled in the State, and some 6,000 are now producing. They started anywhere from five to 250 barrels per day, but now only average sixty-five-one-hundredths barrels in Cattaraugus county, and sixty-two-one-hundredths barrels in Allegany county. With the oil considerable gas has been found, but now there is little more than enough to supply fuel for pumping. "Edge territory "usually produces good gas wells.

### I. Allegany Field.

The Allegany field is the towns of Greenwood in Steuben county, and Andover, Scio, Alma, Bolivar, Wirt, Clarksville and Genesee in Allegany county. There have been up to December 1, 1892, 5,327 wells drilled, and about 4,000 are now producing. On January 1, 1889, 25,105,000 barrels of oil had been taken out. The greatest daily production was in 1882 when 17,000 barrels

marked the limit. At present about 2,500 barrels is the daily production. This field is divided into six pools, viz.: 1. Andover; 2. Alma P. O.; 3. Alma; 4. Bolivar, Richburg and Wirt; 5. Waugh and Porter; 6. Clarksville and Niles.

1. *Andover.*— This is situated in Greenwood, Steuben county, and Andover, Allegany county. It was originally drilled for gas to supply the neighboring towns, and all drilling has been done by the Mutual Gas Company, of Andover. In all, 15 wells have been finished since the field was opened in 1889. In depth the wells run from 800 feet in the valley to 1,300 feet on the hills, with oil sand from 15 to 95 feet thick. The field gives a good yield of both gas and oil, the rock pressure being 350 feet on the average and a yield of one to eight barrels of oil per well per day. At present all the wells but three are shut in, as this number is sufficient to furnish the gas needed.

2. *Alma P. O.*—This really belongs to the Alma pool, but as there is a dry streak between them it has been treated by itself. It is very small, covering only five lots in the southwest corner of the town of Alma. The wells are few and run from 800 to 1,500 feet deep, with only 10 to 20 feet of oil sand. The yield of oil and gas is very small.

3. *Alma.*— This pool is a long narrow strip running northeast and southwest and covering about 30 lots in the town of Alma. There are about 250 producing wells, yielding about 125 barrels of oil daily. In depth they run from 1,100 to 1,200 feet, with 15 to 20 feet of producing oil sand. The southwest edge is good gas territory.

4. *Bolivar, Richburg and Wirt.*— This is the oldest and largest part of the Allegany field. It is situated in the towns of Alma, Scio, Bolivar, Wirt, Genesee and Clarksville. The first wells drilled were at Richburg, in about the center of the field. The wells are deep, ranging from 1,400 to 1,800 feet. The Richburg sand is from 25 to 50 feet thick. The yield now is only a little more than a half barrel a day, but at first ran as high as 100 barrels a day per well.

5. *Waugh and Porter.*— This pool covers seven lots lying in the southern part of the town of Bolivar. It was opened in 1882, and it was here that the fourth or Waugh and Porter sand was discovered. There are in all 36 wells, yielding about 40 barrels of oil daily. In depth they run from 1,350 to 1,700 feet. The oil

sands, the Richburg and Waugh and Porter, are 25 and 28 feet thick respectively, separated by some 100 feet of shale and slate. At the outset the yield was about 10 barrels a day.

6. *Clarksville and Niles.*— These two pools are only about one-half a mile apart and can almost be considered as one in spite of the dry streak between. The former covers 15 lots in the towns of Clarksville and Wirt, and the latter six in the northern part of Wirt. Clarksville was first drilled in 1883, and has about 250 producing wells, while Niles dates one year earlier with about 140 wells. The wells are from 1,000 to 1,500 feet deep, and yielded when first shot from 5 to 25 barrels a day, but are now only doing about half a barrel. The oil sand is thicker in Clarksville than in Niles, being 5 to 60 feet as compared to two to five feet. The gas pressure is light except on the northern edge, where it has been recorded as high as 400 pounds to the square inch.

## II. Cattaraugus County Field.

The territory in this county is a continuation of the Bradford field and comprises part of the towns of Carrollton, Allegany and Olean. The first drilling was done at Limestone in 1865, followed soon after by exploration at Rock City, Four Mile and Knapp's Creek. The field may best be considered by dividing it into two, viz.: A. Bradford (proper); B. Allegany town.

*A. Bradford.*— This portion of the field covers about thirty square miles, its greatest length being twelve and one-half miles, and its average breadth being two and one-half miles. There are now some 1,850 producing wells, yielding about six-tenths of a barrel each daily. In depth they run from 1,600 to 1,800 feet with 18 to 60 feet of good oil sand, although it often happens that the oil sand is badly broken up by shale and slate.

*B. Allegany Town.*— This field is comparatively new, having been opened about five years ago. It is situated in the townof Allegany along the Allegheny river, and is about five miles long by one and one-half wide. There are now about 175 producing wells yielding each about three barrels daily. The oil sand runs about 18 to 25 feet thick, while the wells are 1,000 to 1,200 feet deep. At the start the output ran as high as 40 barrels per well. So far no connection has been made with the Bradford, but there is no reason why it will not be made some day should the price of oil go up to allow drilling to pay.

# Natural Carbonic Acid Gas.

This material is obtained at Saratoga Springs and vicinity by boring wells to a depth of about 350 feet. Carbonated waters flow to the surface and are conducted through pipes to large gas holders, where the gas is separated from the water and is then pumped into compressors from which it is forced into steel cylinders under pressure of about 1,000 pounds to the square inch. These cylinders when filled are shipped to the consumers, who use it chiefly in the manufacture of soda water, both for wholesale and retail sales. At present this gas is shipped from Saratoga Springs to New York, New Jersey, Pennsylvania, Massachusetts, Connecticut and Rhode Island. In addition to the large quantities consumed within this State, it is also being used for refrigerating purposes and in the manufacture of cod liver oil.

# Mineral Waters.

The mineral springs of New York are widely known. In addition to the revenue from mineral springs used for bathing at health resorts, a large industry now exists in the bottling and shipment of mineral waters for domestic consumption.

**List of Mineral Springs in New York which are Commercially Productive.**

Adirondack Mineral Springs (H. V. Knight), Whitehall, Washington county.

Avon Sulphur Springs (O. D. Phelps), Avon, Livingston county.

Artesian Lithia Spring (C. O. McCreedy), Ballston Spa, Saratoga county.

Cairo White Sulphur Spring (H. K. Lyon), Cairo, Greene county.

Cayuga Mineral Spring (Lucius Baldwin), Cayuga, Cayuga county.

Chittenango White Sulphur Springs (W. H. Young), Chittenango, Madison county.

Chlorine Springs (J. L. Grover), Syracuse, Onandaga county.

Clifton Springs (Dr. Henry Foster), Clifton Springs, Ontario county.

Dansville Springs (J. Arthur Jackson, secretary and manager), Dansville, Livingston county.

Deep Rock Spring (Deep Rock Spring Co.), Oswego, Oswego county.

Massena Springs (Shedden & Stearns), Massena, St. Lawrence county.

Nunda Mineral Springs (Daniel Price), Nunda, Livingston county.

Reid's Mineral Spring (J. R. McNeil), South Argyle, Washington county.

Richfield Springs (T. R. Proctor), Richfield Springs, Otsego county.

Champion Spring (J. Z. Formel), Saratoga Springs, Saratoga county.

Empire Spring (H. W. Hayes, manager), Saratoga Springs, Saratoga county.

Excelsior Spring (F. W. Lawrence), Saratoga Springs, Saratoga county.

Geyser Springs (Geyser Spring Co.), Saratoga Springs, Saratoga county.

Hathorn Spring (Hathorn Spring Co.), Saratoga Springs, Saratoga county.

Old Red Spring (E. H. Peters, superintendent), Saratoga Springs, Saratoga county.

Vichy Springs (L. A. James, superintendent), Saratoga Springs, Saratoga county.

Sharon Springs (John H. Gardner & Son), Sharon Springs, Schoharie county.

Slaterville Magnetic Springs (W. J. Carns & Son), Slaterville, Tompkins county.

Verona Mineral Springs (A. A. Hunt, M. D.), Verona, Oneida county.

White Sulphur Springs (T. C. Luther), Ballston Spa, Saratoga county.

White Sulphur Springs (J. Hochstatter), Berne, Albany county.

Star Spring, Saratoga Springs.

Elkhorn Spring (Clark Snook), Manlius.

Royal Spring (A. Putnam, Jr., president), Saratoga Springs, Saratoga county.

Lebanon Thermal Spring (P. Carpenter), Lebanon Springs.

Crystal Rock Water Co. (L. G. Deland, president), Fairport.

Victor Spring (H. J. Dickinson, Buffalo), Darien, Genesee county.

Geneva Magnetic Mineral Spring (C. A. Steele), Geneva, N. Y., Ontario county.

Oneita Springs (Oneita Spring Co.), Utica, N. Y., Oneida county.

Empire Seneca Spring (M. W. Cobb, of Fredonia), Dunkirk N. Y., Chautauqua county.

Crystal Spring (Asa D. Baker), Barrington, N. Y., Yates county.

Great Bear Spring, Fulton, Oswego county.

The following list of New York springs and their analyses was compiled by Mr. A. C. Peale, of the United States Geological Survey, and published in Bulletin No. 32 of that organization.

# Mineral Springs of New York.

| NAME AND LOCATION. | Number of springs. | Flow in gallons per hour. | Temperature (Degrees Fahr.). | Character of the water. | Remarks. |
|---|---|---|---|---|---|
| Adirondack Mineral Springs, Whitehall, Washington county. | 2 | 200 | 38 | Chalybeate..... | Used commercially. |
| Albany Artesian Well (500 feet), Albany, Albany county. | 1 | ..... | ..... | Saline ..... | |
| Auburn Spring, 4 miles west of Auburn, Cayuga county. | 1 | ..... | ..... | Sulphureted .... | Has a local reputation and is sold to small extent. |
| Avon Sulphur Springs, Avon, Livingston county. | 4 | 7,660 | 50 | do .... | Used commercially and as a resort. |
| Ballston Spa Springs, Ballston, Saratoga county. | ..... | ..... | ..... | ..... | Resort. |
| Artesian Lithia Spring..... | 1 | 5 | 52 | Saline... ..... | Used commercially. |
| Franklin Spring ..... | 1 | ..... | 52 | do ..... | |
| Iron Spring..... | 1 | 4,000 | ..... | do ..... | |
| Sans Souci Spring..... | 1 | ..... | ..... | do ..... | |
| United States Spring ..... | 1 | ..... | 50 | do ..... | |
| Washington Lithia Well..... | 1 | ..... | 49 | do ..... | do |
| Barton Sulphur Spring, near Waverly, Tioga county. | ..... | ..... | ..... | ..... | |
| Byron Acid Spring, Byron, Genesee county. | ..... | ..... | ..... | Acid ..... | |
| Cairo White Sulphur Springs, Cairo, Greene county. | ..... | ..... | ..... | Sulphureted .... | Resort. |
| Calcic springs: | | | | | |
| Near Sempronius, Cayuga county.. | ..... | ..... | ..... | ..... | |
| Near Chateaugay, Franklin county | ..... | ..... | ..... | ..... | |
| On Otsquago Creek, Stark Township, Herkimer county. | ..... | ..... | ..... | ..... | |
| Near Starkville, Herkimer county. | ..... | ..... | ..... | ..... | |
| At Caledonia, Livingston county .. | ..... | ..... | ..... | ..... | |
| Near Cartersville, Monroe county.. | ..... | ..... | ..... | ..... | Unimproved. |
| In southwestern part of Wheatland Township, Monroe county. | ..... | ..... | ..... | ..... | do |
| In Cather's Cave, near Niagara Falls, Niagara county. | ..... | ..... | ..... | ..... | |
| Near Syracuse, Onondaga county .. | ..... | ..... | ..... | ..... | |
| At Manlius Centre, Onondaga county. | ..... | ..... | ..... | ..... | |
| At Onondaga, Onondaga county... | ..... | ..... | ..... | ..... | |
| North of Otisco lake outlet, Onondaga county. | ..... | ..... | ..... | ..... | |
| At Schoharie, Schoharie county.... | ..... | ..... | ..... | ..... | |
| Four miles northwest of Gouverneur, St. Lawrence county. | ..... | ..... | ..... | ..... | |
| Near Ithaca, Tompkins county..... | ..... | ..... | ..... | ..... | |
| In Washington county..... | ..... | ..... | ..... | ..... | |
| Canoga Springs, Canoga, Seneca county | ..... | ..... | ..... | ..... | |
| Cayuga Mineral Spring, 2½ miles north of Cayuga, Cayuga county. | 1 | 50 | ..... | ..... | Used commercially. |
| Chalybeate springs: | | | | | |
| Five miles northwest of Auburn, Cayuga county. | ..... | ..... | ..... | ..... | Used locally for medicinal purposes. |
| Four or five miles from West Troy, Albany county. | ..... | ..... | ..... | ..... | |
| South of Canaan Centre, Columbia county. | ..... | ..... | ..... | ..... | |
| Livingston, Columbia county ..... | ..... | ..... | ..... | ..... | |
| Near Sidney Plains, Delaware county. | ..... | ..... | ..... | ..... | |
| Two miles from Bloomville, Delaware county. | ..... | ..... | ..... | ..... | |
| Three miles above Walton, Delaware county. | ..... | ..... | ..... | ..... | |
| Near Upton pond, Dutchess county | ..... | ..... | ..... | ..... | |
| Near Kline's Corners, Dutchess county. | ..... | ..... | ..... | ..... | |
| Near Williamsville, Erie county... | ..... | ..... | ..... | ..... | |
| Two miles north of Elba, Genesee county. | ..... | ..... | ..... | ..... | |
| North part of Warren Township, Herkimer county. | ..... | ..... | ..... | ..... | |
| Bethel, in Stark Township, Herkimer county. | ..... | ..... | ..... | ..... | |
| South part of Pittsford Township, Monroe county. | ..... | ..... | ..... | ..... | Unimproved. |
| Near Lewiston, Niagara county.... | ..... | ..... | ..... | ..... | |
| Van Buren Township, Onondaga county. | ..... | ..... | ..... | ..... | |
| Near West Point, Orange county... | ..... | ..... | ..... | ..... | |
| Shawangunk Mt., Orange county.. | ..... | ..... | ..... | ..... | |

## Mineral Springs of New York — (*Continued*).

| NAME AND LOCATION. | Number of springs. | Flow in gallons per hour. | Temperature (Degrees Fahr.). | Character of the water. | Remarks. |
|---|---|---|---|---|---|
| Chalybeate springs — (*Continued*): | | | | | |
| Near Sand Lake, Rensselaer county | ..... | ..... | ..... | ..... | |
| In Richmond county | ..... | ..... | ..... | ..... | |
| Between West Neck and Lloyd's Neck, Suffolk county. | ..... | ..... | ..... | ..... | |
| Near North Blenheim, Schoharie county. | ..... | ..... | ..... | ..... | |
| In Steuben county | ..... | ..... | ..... | ..... | |
| Three miles from Sag Harbor, Suffolk county. | ..... | ..... | ..... | ..... | |
| Horton's Point, Suffolk county | ..... | ..... | ..... | ..... | Small and unimportant |
| Hudson's Point, Riverhead, Suffolk county. | ..... | ..... | ..... | ..... | |
| East Hampton, Suffolk county | ..... | ..... | ..... | ..... | |
| At Little Cow Harbor, Suffolk county. | ..... | ..... | ..... | ..... | Unimportant. |
| At North Salem, Westchester county. | ..... | ..... | ..... | ..... | |
| Chappaqua Spring, Chappaqua, Westchester county. | ..... | ..... | ..... | ..... | |
| Cherry Valley Phosphate Spring, Cherry Valley, Otsego county. | 1 | 10 | .... | ..... | Not used at present. |
| Cherry Valley Springs, Cherry Valley, Otsego county. | 2 | ..... | ..... | Sulphureted .... | |
| Chittenango White Sulphur Springs, Chittenango, Madison county. | 3 | ..... | 49½ | do .... | Resort. |
| Chlorine Springs, Syracuse, Onondaga county. | 5 | 2,000 | 49 | Saline..... | Used commercially and as a resort. |
| Clifton Springs, Clifton Springs, Ontario county. | 3+ | ..... | 54 | Sulphureted .... | Resort. |
| Clinton Spring, Cliff street, New York, New York county. | ..... | ..... | ..... | ..... | |
| Columbia White Sulphur Springs, 4 miles north of Hudson, Columbia county. | 4 | ..... | 55 | Saline, sulphureted. | do |
| Crystal Springs, Crystal Spring, Yates county. | 6 | 1,250+ | 48 | ..... | do |
| Dansville Springs, Dansville, Livingston county. | 4 | 1,000 | ..... | Alkaline, calcic. | Sanitarium and resort. |
| Darien Mineral Spring, Darien Centre, Genesee county. | 1 | 40? | ..... | Acid ..... | Used commercially. |
| Darrow Spring, south of Baldwinsville, Onondaga county. | 1 | ..... | ..... | Calcic, sulphur. | Has a local reputation. |
| Deep Rock Springs, Oswego, Oswego county. | 2 | ..... | 50 | Sulphureted, saline. | Used commercially and as a resort. |
| Diamond Rock Mineral Well, Williamson, Wayne county. | 1 | 30 | 44 | Sulpho-saline ... | Used commercially and as a resort. |
| Doxtatter's Mineral Well (Longmuir's Well), Rochester, Monroe county. | 1 | ..... | 52 | Saline, sulphureted. | Used for bathing. |
| Dryden Springs, ½ mile west of Dryden, Tompkins county. | .... | ..... | 48 to 54 | Chalybeate and sulphureted, saline. | Resort. |
| Elkhorn Springs, north of Manlius Village, Onondaga county. | 3 | ..... | 50 | Saline, sulphureted. | Local resort. |
| Excelsior Spring, Syracuse, Onondaga county. | 1 | 1,000 | 48 | Saline..... | Used commercially and as a resort. |
| Fairport Mineral Springs, Fairport, Monroe county. | 2 | ..... | ..... | Sulphureted,etc. | Has a local reputation. |
| Florida Springs, Florida Township, Montgomery county. | 2 | ..... | 43 | Sulphureted .... | Local resort. |
| Franklin Springs, Cowlesville, Wyoming county. | 1 | ..... | 40 | ..... | Resort. |
| Grove Springs, near Hammondsport, Steuben county. | ..... | ..... | ..... | ..... | |
| Halleck's Spring, near Westmoreland, Oneida county. | 1 | ..... | ..... | Saline..... | Was improved and used as a resort about 1838 to 1840, but is now unimproved. |
| Harrowgate Springs, Rensselaer county, 3 miles from Albany. | ..... | ..... | .... | Sulphureted .... | |
| Kingsley Springs, near Marion, Wayne county. | 3 | ..... | 40 | Saline?..... | Unimproved. |
| Lebanon Thermal Spring, Lebanon Springs, Columbia county. | 1 | 30,000 | 75 | Chalybeate..... | Used commercially and as a resort. |
| Lockport Mineral Spring, 1½ miles north of Lockport, Niagara county. | ..... | ..... | ..... | Saline..... ..... | Unimproved, but used by residents of Lockport. |
| Madrid Springs, Madrid Springs, St. Lawrence county. | ..... | ..... | ..... | ..... | Unimproved at present. |

## Mineral Springs of New York—(*Continued*).

| NAME AND LOCATION. | Number of springs. | Flow in gallons per hour. | Temperature (Degrees Fahr.). | Character of the water. | Remarks. |
|---|---|---|---|---|---|
| Massena or St. Regis Springs, St. Lawrence county. | 2 | 700+ | 45 | Saline, sulphureted. | Used commercially and as a resort. |
| Massena Sulphur Springs, 3 miles east of Syracuse, Onondaga county. | 3 | 5 | 50 | Sulphureted .... | |
| Mineral Springs, 1½ miles northwest of Cayuga, Cayuga county. | ..... | ..... | ..... | ..... | Has local reputation and is sold. |
| Mineral Springs, Mineral Springs, Schoharie county. | 2 | 120 | 44 | ..... | Unimproved at present; was once a resort. |
| Mineral springs: | | | | | |
| At Watervliet Centre, Albany county. | ..... | ..... | ..... | Sulphureted, chalybeate, carbonated. | |
| At Montezuma, Cayuga county .... | ..... | ..... | ..... | Saline..... | Unimportant. |
| Near Crown Point, Essex county.. | ..... | ..... | .... | do .... ..... | |
| Northwestern part of Columbia Township, Herkimer county. | ..... | .... ... | ..... | ..... | |
| Two miles northeast of Pittsford, Monroe county. | ..... | ..... | ..... | Saline, sulphureted. | Sold to some extent. |
| North of Elbridge, Onondaga county. | 1 | ..... | ..... | Saline?..... | Unimproved. |
| At Quaker Springs, Saratoga county. | ..... | ..... | ..... | Sulphureted..... | do |
| Monroe Springs, 5 miles from Rochester, Monroe county. | ..... | ..... | .... . | do .... | |
| Nanticoke Sulphur Springs, near Lamb's Corners, Broome county. | ..... | ..... | ..... | ..... | |
| Nunda Mineral Springs, Nunda, Livingston county. | 3 | 30 | ..... | Saline..... ... | Resort and water is sold. |
| Oak Orchard Acid Springs, Alabama, Genesee county. | 8 | ..... | ..... | Acid and chalybeate. | Used commercially. |
| Pitcher Springs, Pitcher Springs, Chenango county. | ..... | ..... | ..... | Sulphureted .... | |
| Pittsford Sulphur Springs, Olcott's farm, northwest part of Pittsford Township, Monroe county. | ..... | ..... | ... .. | do .... | Once a resort. |
| Reid's Mineral Spring, South Argyle, Washington county. | 1 | 8 | ..... | Carbonated, saline. | Local resort. |
| Richfield Springs, Richfield Springs, Otsego county. | 3 | ..... | 47 | Sulphureted, chalybeate and saline. | Resort. |
| Riga Mineral Springs, Riga, Monroe county. | ..... | ..... | ..... | Carbonated, chalybeate. | |
| Sauquoit Sulphur Spring, near Sauquoit, Oneida county. | 1 | 4 | ..... | Saline ..... | Unimproved. |
| Saratoga Springs, Saratoga county .... | ..... | ..... | ..... | ..... | Resort. |
| Champion Spring..... ..... | 1 | 2,500 | 49 | Saline carbonated. | Used commercially. |
| Columbian Springs..... | 4 | ..... | 55 | Saline carbonated. | do |
| Congress Spring ..... | ..... | ..... | 51 | Saline carbonated. | do |
| Crystal Springs..... | 6 | 129 | ..... | . ..... | |
| Ellis Spring ..... | 1 | ..... | ... . | ..... ..... | Surface spring. |
| Empire Spring..... ... | ..... | ..... | ..... | Saline carbonated. | Used commercially. |
| Eureka Spring ..... ..... | ..... | ..... | ..... | ..... | Not in general use at present. |
| Excelsior Spring ..... | 1 | 33 | 45 | Saline carbonated. | Used commercially. |
| Flat Rock Spring..... ..... | ..... | ..... | ..... | Saline carbonated. | |
| Geyser Spring ..... | 3 | 900+ | 46 | Saline carbonated. | do |
| Hamilton Spring ..... | ..... | ..... | 49½ | ..... | |
| Hathorn Spring..... | ..... | ..... | ..... | Saline carbonated. | do |
| High Rock and Apollis Springs .... | 2 | 1,000 | ..... | Saline carbonated. | do |
| Indian Encampment Spring..... | ..... | ..... | .. ... | ..... ..... | Abandoned. |
| Lake Sulphur Spring..... .... | ..... | ..... | ..... | ..... | |
| Minnehaha Spring..... | ..... | ..... | ..... | ..... | |
| Monroe Spring..... ..... | ..... | ..... | ..... | ..... | |
| Old Red Spring ..... ..... | 1 | 60 | ..... | Saline carbonated. | Used commercially. |
| Pavilion Spring..... | 1 | 12,000 | 50 | Saline carbonated. | Not used commercially at present. |
| Putnam Springs ..... | 2 | 24 | 40 | Saline carbonated. | Used commercially. |
| Saratoga A (or alum) Spring... .... | ..... | ..... | ..... | ..... | |

## Mineral Springs of New York — (*Continued*).

| NAME AND LOCATION. | Number of springs. | Flow in gallons per hour. | Temperature (Degrees Fahr.). | Character of the water. | Remarks. |
|---|---|---|---|---|---|
| Saratoga Springs — (*Continued*). | | | | | |
| Saratoga Seltzer Spring | 1 | ..... | 50 | Saline carbonated. | Not used commercially at present. |
| Star Spring (formerly Walton or Iodine Spring). | 1 | 80 | 50 | Saline carbonated. | Used commercially. |
| Triton Spring (Kissingen) | ..... | ..... | ..... | ..... | do |
| Union Spring | 1 | 12 | 48 | Saline carbonated. | do |
| United States Spring | ..... | ..... | ..... | ..... | |
| Vichy Spring | 1 | 240 | 50 | Alkaline, saline carbonated. | do |
| Walton Spring (same as Star) | ..... | ..... | ..... | ..... | |
| Washington Spring | ..... | ..... | 45 | Carbonated saline. | do |
| White Sulphur Springs | 2 | 2,400+ | 48 | ..... | Used for bathing. |
| Seneca Spa or Deer Lick Springs, 4 miles east of Buffalo, Erie county. | ..... | ..... | ..... | Sulphureted | |
| Sharon Springs, Sharon Springs, Schoharie county. | 5 | 7,680+ | 48 | Alkaline and saline, sulphureted. | Used commercially and as a resort. |
| Shee's Spa, McDonough Township, Chenango county. | ..... | ..... | ..... | Sulphureted | |
| Slaterville Magnetic Springs, Slaterville, Tompkins county. | 27 | 2,700? | 47 | ..... | Used commercially and as a resort. |
| Spencer Springs, Spencer, Tioga county. | ..... | ..... | ..... | ..... | |
| Sulphur springs: | | | | | |
| At Wendell's Hollow, near Albany, Albany county. | ..... | ..... | ..... | ..... | |
| At Coeymans, Albany county | ..... | ..... | ..... | ..... | |
| At Guilderland, Albany county | ..... | ..... | ..... | ..... | |
| Four miles west of Rensselarville, Albany county. | ..... | ..... | ..... | ..... | |
| Two miles west of Auburn, Cayuga county. | ..... | ..... | ..... | ..... | Unimproved. |
| One and one-half miles north of Auburn, Cayuga county. | ..... | ..... | ..... | ..... | do |
| Two miles north of Union Springs, Cayuga county. | 2 | ..... | ..... | ..... | |
| Near Randolph, Cattaraugus county. | ..... | ..... | ..... | ..... | |
| Near Van Buren Harbor, Chautauqua county. | ..... | ..... | ..... | ..... | |
| Near Fredonia, Chautauqua county | ..... | ..... | ..... | ..... | |
| Near Sheridan, Chautauqua county | ..... | ..... | ..... | ..... | |
| Near Laona, Chautauqua county | ..... | ..... | ..... | ..... | do |
| Two miles from Norwich, Chenango county. | ..... | ..... | ..... | ..... | |
| Near Pharsalia, Chenango county | ..... | ..... | ..... | ..... | |
| Near Beekmantown, Clinton county. | ..... | ..... | ..... | ..... | |
| Near Kinderhook, Columbia county | ..... | ..... | ..... | ..... | do |
| Near Millers, in Claverack Township, Columbia county. | ..... | ..... | ..... | ..... | Unimportant. |
| At Oakhill, near Catskill, Columbia county. | ..... | ..... | ..... | ..... | Unimproved. |
| At Preble, Cortland county | ..... | ..... | ..... | ..... | |
| Three miles from Chehocton, Delaware county. | ..... | ..... | ..... | ..... | |
| Near Amenia, Dutchess county | ..... | ..... | ..... | ..... | do |
| At Grand Island, Erie county | ..... | ..... | ..... | ..... | |
| In Amherst Township, Erie county, | ..... | ..... | ..... | ..... | |
| Clarence Township, Erie county | ..... | ..... | ..... | ..... | |
| One and one-half miles west of Durham, Greene county. | ..... | ..... | ..... | ..... | do |
| One mile from Catskill, Greene county. | ..... | ..... | ..... | ..... | do |
| Three-fourths mile west of Athens, Greene county. | ..... | ..... | ..... | ..... | |
| Four miles west of Athens, Greene county. | ..... | ..... | ..... | ..... | |
| Near Richfield Springs, Warren Township, Herkimer county. | 6 | ..... | ..... | ..... | Used locally. |
| Near Starkville, Herkimer county, | ..... | ..... | ..... | ..... | |
| Near Winfield, Herkimer county | ..... | ..... | ..... | ..... | |
| In Danube Township, Herkimer county. | ..... | ..... | ..... | ..... | |
| At Mohawk, Herkimer county | ..... | ..... | ..... | ..... | |
| Near Newville, Herkimer county | ..... | ..... | ..... | ..... | |

## Mineral Springs of New York — (*Concluded*).

| NAME AND LOCATION. | Number of springs. | Flow in gallons per hour. | Temperature (Degrees Fahr.). | Character of the water. | Remarks. |
|---|---|---|---|---|---|
| Sulphur springs — (*Continued*). | | | | | |
| Near Martinsburg, Lewis county | | | | | |
| At Caledonia, Livingston county | | | | | |
| One-half mile south of Spencerport, Monroe county. | | | | | |
| In Gates Township, Monroe county | | | | | |
| In Mendon Township, Monroe county. | | | | | |
| At Ogden, Monroe county | | | | | |
| In Deep Hollow valley, northwestern part of Rochester, Monroe county. | | | | | Used locally. |
| In Niagara county, 2 miles from Tonawanda. | | | | | |
| Near Niagara Falls, Niagara county | | | | | |
| Above Lewiston, Niagara county | | | | | |
| North part of Pendleton Township, Niagara county. | | | | | |
| In Augusta, Oneida county | | | | | |
| Near Vernon, Oneida county | | | | | |
| Near Paris, Oneida county | | | | | |
| West of Elbridge, Onondaga county | | | | | |
| South of Manlius village, Onondaga county. | | | | | |
| In Caruthers (?) Township, Onondaga county. | | | | | |
| Near Syracuse, Onondaga county | | | | | |
| Near Split Rock, Onondaga county. | | | | | |
| Lake Sodom, near Manlius Centre, Onondaga county. | | | | | |
| In La Fayette Township, Onondaga county. | | | | | Used locally for medicinal purposes. |
| At outlet of Canandaigua lake, Ontario county. | | | | | |
| Two and one-half miles from Newburgh, Orange county. | | | | | |
| In New Windsor Township, Orange county. | | | | | |
| In Holley, Orleans county | 2 | | | | Weak and unimportant. |
| North end of Troy, Rensselaer county. | | | | | |
| Near Bath, Rensselaer county | | | | | |
| Near Waterloo, Seneca county | | | | | |
| Near Campbell, Steuben county | 1 | | | | Unimportant. |
| At Jasper, Steuben county | 10 | | | | |
| Near Hammondsport, Steuben county. | | | | | |
| Two and one-half miles southwest of Sag Harbor, Suffolk county. | | | | | |
| At Tioga Centre, Tioga county | | | | | |
| West of Springtown, Ulster county. | | | | | |
| Two miles southeast of Ithaca, Tompkins county. | | | | | |
| Near Newark, Wayne county | | | | | Unimportant. |
| Near Palmyra, Wayne county | | | | | Unimportant. |
| In Sodus Township, Wayne county. | | | | | |
| At Clyde, Wayne county | 3 | | | | Unimportant. |
| Near Marion, Wayne county | 4 | | | | Only one spring utilized. |
| Sulphur well, Peterson's farm, northwest of Rochester, Monroe county. | | | | | Unimproved. |
| Sulphuric acid springs: | | | | | |
| North part of Alabama Township, Genesee county. | | | | | |
| In Elba Township, Genesee county. | | | | | |
| Near South Byron, Genesee county. | | | | | |
| Union Springs, Union Springs, Cayuga county. | 2 | 10 | | Sulphureted and chalybeate. | Unimproved. |
| Vallonia Springs, Vallonia Springs, Broome county. | | | | | |
| Verona Mineral Springs, near Verona, Oneida county. | 4 | 160+ | 48 | Saline | Used to some extent commercially and as a resort. |
| Victor Spring, Darien Centre, Genesee county. | 1 | 40 | | Acid saline | Used commercially. |
| Yates Sulphur Springs, 1 mile south of Chittenango, Madison county. | | | | | |
| Yellow Spring, Southampton (Long Island), Suffolk county. | | | | Chalybeate | Unimportant. |

## Analyses of Mineral Springs in New York.

| CONSTITUENTS. | Adirondack Spring. | Albany Artesian Well. | | Auburn Spring, West Auburn. |
|---|---|---|---|---|
| *Solids.* | *Grains per gallon.*a | *Grains per gallon.*b | *Grains per gallon.*c | *Grains per gallon.*d |
| Sodium carbonate | 5.14 | 40.00 | 40.00 | ..... |
| Potassium carbonate | 5.32 | ..... | ..... | ..... |
| Calcium carbonate | 18.54 | 32.00 | 32.00 | ..... |
| Magnesium carbonate | 16.62 | 16.00 | 12.00 | ..... |
| Lithium carbonate | 0.02 | ..... | ..... | ..... |
| Manganese carbonate | Trace. | ..... | ..... | ..... |
| Iron carbonate | 5.04 | e 8.00 | 8.00 | ..... |
| Calcium sulphate | 11.13 | ..... | ..... | 120.00 |
| Magnesium sulphate | ..... | ..... | ..... | 25.60 |
| Sodium chloride | 14.34 | 504.00 | 472.00 | 6.00 |
| Calcium chloride | ..... | ..... | 4.00 | ..... |
| Magnesium chloride | ..... | ..... | ..... | 2.00 |
| Alumina | Trace. | ..... | ..... | ..... |
| Silica | 0.74 | ..... | ..... | ..... |
| Total | 76.89 | 600.00 | 568.00 | 153.60 |
| *Gases.* | *Cubic inches.* | *Cubic inches.* | *Cubic inches.* | *Cubic inches.* |
| Sulphureted hydrogen | ..... | ..... | ..... | 12.00 |
| Carbonic acid | 67.27 | 184.00 | ..... | ..... |
| Total | 67.27 | 184.00 | 208.00 | 12.00 |

| CONSTITUENTS. | Avon Sulphur Springs. | | | |
|---|---|---|---|---|
| | Upper Spring.f | Lower Spring. | New Bath Spring. | Congress Hall Spring. |
| *Solids.* | *Grains per gallon.*g | *Grains per gallon.*d | *Grains per gallon.*c | *Grains per gallon.*h |
| Calcium carbonate | 8.00 | 29.33 | 26.96 | 9.25 |
| Sodium sulphate | 16.00 | 13.73 | 38.72 | 21.02 |
| Calcium sulphate | 84.00 | 57.44 | 3.52 | 27.61 |
| Magnesium sulphate | 10.00 | 49.61 | 8.08 | 19.07 |
| Sodium chloride | 18.40 | ..... | 5.68 | 29.11 |
| Calcium chloride | ..... | 8.41 | ..... | ..... |
| Sodium iodide | ..... | i Trace. | ..... | ..... |
| Sodium sulphide | ..... | ..... | ..... | 99.55 |
| Calcium sulphide | ..... | ..... | ..... | |
| Magnesium sulphide | ..... | ..... | ..... | |
| Total | 136.40 | 158.52 | 82.96 | 205.61 |
| *Gases.* | *Cubic inches.* | *Cubic inches.* | *Cubic inches.* | *Cubic inches.* |
| Sulphureted hydrogen | 12.00 | 10.02 | 31.28 | 27.63 |
| Carbonic acid | 5.60 | 3.92 | ..... | 22.04 |
| Oxygen | ..... | 0.56 | ..... | 0.97 |
| Nitrogen | ..... | 5.42 | ..... | 3.88 |
| Total | 17.60 | 19.92 | ..... | 54.52 |

a C. Collier, analyst. b Wm. Meade, analyst (1827). c L. C. Beck, analyst (1842).
d J. R. Chilton, analyst. e With silica. f Same as Middle Spring of Beck's report.
g J. Hadley, analyst. h H. M. Baker, analyst (1874). i Contains iodine and bromine.

## Analyses of Mineral Springs in New York — (*Continued*).

| CONSTITUENTS. | Ballston Spa Springs. | | | | |
|---|---|---|---|---|---|
| | Sans Souci Spring. | Artesian Lithia Spring. | Franklin Artesian Well. | United States | Washington Lithia Well (Old Conde Dentonian). |
| *Solids.* | *Grains per gallon.*a | *Grains per gallon.*b | *Grains per gallon.*c | *Grains per gallon.*d | *Grains per gallon.*e |
| Sodium carbonate | 12.66 | ..... | ..... | 16.88 | ..... |
| Sodium bicarbonate | ..... | 11.93 | 94.60 | ..... | 34.40 |
| Calcium carbonate | 43.41 | ..... | ..... | f 29.20 | ..... |
| Calcium bicarbonate | ..... | 238.16 | 202.33 | ..... | 173.48 |
| Magnesium carbonate | ..... | ..... | ..... | 5.76 | ..... |
| Magnesium bicarbonate | 39.10 | 180.60 | 177.87 | ..... | 158.35 |
| Strontium bicarbonate | ..... | 0.87 | Trace | ..... | 0.19 |
| Lithium bicarbonate | ..... | 7.75 | 6.78 | ..... | 15.51 |
| Iron carbonate | 5.95 | ..... | ..... | ..... | ..... |
| Iron bicarbonate | ..... | 1.58 | 1.61 | ..... | 2.30 |
| Barium bicarbonate | ..... | 3.88 | 1.23 | ..... | 4.74 |
| Sodium sulphate | ..... | ..... | ..... | 1.76 | ..... |
| Potassium sulphate | ..... | 0.52 | 0.76 | ..... | ..... |
| Sodium phosphate | ..... | 0.05 | 0.01 | ..... | Trace |
| Sodium biborate | ..... | Trace | Trace | ..... | Trace |
| Sodium chloride | 143.73 | 750.03 | 659.34 | 424.96 | 645.48 |
| Potassium chloride | ..... | 33.28 | 33.93 | ..... | 9.23 |
| Sodium bromide | ..... | 3.64 | 4.67 | ..... | 2.37 |
| Calcium fluoride | ..... | Trace | Trace | ..... | Trace |
| Sodium iodide | 1.30 | 0.12 | 0 24 | ..... | 0.22 |
| Alumina | ..... | 0 08 | 0.26 | ..... | 0.40 |
| Silica | 1.00 | 0.76 | 0.74 | 8.00 | 1.03 |
| Organic matter | ..... | Trace | Trace | ..... | Trace |
| Total | 247.15 | 1,233.25 | 1,184.37 | 486.56 | 1,047.70 |
| *Gases.* | | | | | |
| Carbonic acid | ..... | 426.114 | 460.066 | 244.00 | 353.345 |

| CONSTITUENTS. | Chittenango Springs. | | | Clifton Springs Sulphur Spring. | Columbia White Sulphur Springs. |
|---|---|---|---|---|---|
| | White Sulphur Spring. | Cave Spring. | Magnesia Spring. | | |
| *Solids.* | *Grains per gallon.*c | *Grains per gallon.*c | *Grains per gallon.*c | *Grains per gallon* g | *Grains per gallon.*h |
| Calcium carbonate | ..... | ..... | ..... | 9.68 | 21.79 |
| Magnesium carbonate | ..... | ..... | ..... | 13.12 | ..... |
| Magnesium bicarbonate | 22.02 | 23.97 | ..... | ..... | ..... |
| Iron carbonate | ..... | ..... | 20.78 | ..... | ..... |
| Iron bicarbonate | 0.08 | 0.16 | 0.32 | ..... | ..... |
| Sodium hyposulphite | ..... | 0.26 | 0.02 | ..... | 8.15 |
| Sodium sulphate | 0.21 | ..... | ..... | 7.76 | ..... |
| Calcium sulphate | 81.42 | 106.12 | 115.09 | 69.20 | 64.94 |
| Strontium sulphate | Trace | Trace | Trace | ..... | ..... |
| Magnesium sulphate | 1.95 | 7.59 | 12.72 | 16.48 | ..... |
| Sodium phosphate | ..... | ..... | ..... | ..... | 2.14 |
| Sodium chloride | 1.04 | 1.57 | 1.83 | 9.28 | 84.72 |
| Calcium chloride | ..... | ..... | ..... | 4.08 | ..... |
| Potassium chloride | 0.16 | 0.23 | 0.33 | ..... | 1.19 |
| Magnesium chloride | ..... | ..... | ..... | 4.08 | 31.43 |
| Lithium chloride | Trace | Trace | Trace | ..... | ..... |
| Iron sesquichloride | ..... | ..... | ..... | ..... | 3.42 |
| Sodium sulphide | 0.12 | 0.39 | 0.75 | ..... | ..... |
| Calcium sulphide | ..... | 1.12 | 0 93 | ..... | ..... |
| Alumina | 0.08 | 0.22 | Trace | ..... | ..... |
| Silica | 0.28 | 0.52 | 0.58 | ..... | ..... |
| Sulphur | Trace | ..... | ..... | ..... | ..... |
| Loss | ..... | ..... | ..... | ..... | 0.82 |
| Organic matter | ..... | ..... | ..... | Trace | ..... |
| Total | 107.36 | 142.15 | 153.35 | 133.68 | 218.60 |
| *Gases.* | *Cubic inches.* | *Cubic inches.* | *Cubic inches.* | *Cubic inches.* | *Cubic inches.* |
| Sulphureted hydrogen | 0.884 | 2 754 | 5.623 | Present | 4.491 |
| Carbonic acid | 20.480 | 15.934 | 19.436 | Present | ..... |

a John H. Steele, analyst (1830). b C. F. Chandler, analyst (1868). c C. F. Chandler, analyst. d L. C. Beck, analyst. e C. F. Chandler, analyst (1869). f With iron oxide. g J. R. Chilton, analyst (1852). h Atwood, analyst.

## Analyses of Mineral Springs in New York — (*Continued*).

| CONSTITUENTS. | Barton Sulphur Springs. | Cherry Valley Springs | | |
|---|---|---|---|---|
| | | Bath-house Spring. | Spring north of bath-house. | Phosphate Spring. |
| *Solids.* | *Grains per gallon.*a | *Grains per gallon.*b | *Grains per gallon.*c | *Grains per gallon.*c |
| Sodium carbonate | 11.12 | | | |
| Calcium carbonate | 3.65 | 9.41 | 14.75 | 2.87 |
| Magnesium carbonate | 1.99 | 17.82 | 9.96 | 4.58 |
| Iron carbonate | | | 2.45 | 0.62 |
| Ammonium carbonate | 6.95 | | | |
| Sodium sulphate | | 11.08 | | |
| Calcium sulphate | 0.20 | 57.68 | 149.46 | 5.27 |
| Magnesium sulphate | | 24.56 | | |
| Calcium phosphate | | | | 13.77 |
| Sodium chloride | 2.05 | 12.44 | 2.13 | 0.47 |
| Calcium chloride | | 2.80 | | |
| Potassium chloride | 0 11 | | 2.49 | |
| Magnesium chloride | | 3.68 | | |
| Calcium sulphide | | 0.60 | | |
| Iron oxide | 0.36 | 0.36 | | |
| Alumina | | | | |
| Silica | 1.16 | | 3.64 | 0.62 |
| Sulphur | 1.52 | | | |
| Organic matter | | 0.28 | | |
| Carbonic acid | 2.62 | | | |
| Total | 31.73 | 140 71 | 184.88 | 28.20 |
| *Gases.* | | | | |
| Oxygen | 0.20 | | | |

| CONSTITUENTS. | Cherry Valley Springs. | Yates Sulphur Springs. | Doxtatter's, or Longmuir's Well, Rochester. | Verona Mineral Springs. |
|---|---|---|---|---|
| | Phosphate Spring. | | | |
| *Solids.* | *Grains per gallon.*d | *Grains per gallon* e | *Grains per gallon.*e | *Grains per imp. gal.*f |
| Calcium carbonate | | 7.04 | g 11.84 | 38.47 |
| Magnesium bicarbonate | 17.27 | | | |
| Manganese bicarbonate | 0.01 | | | |
| Iron bicarbonate | 0.20 | | | |
| Sodium sulphate | 0.04 | 13.28 | 55.92 | |
| Calcium sulphate | 41.13 | 102.00 | | 63.19 |
| Magnesium sulphate | 0.47 | | | |
| Potassium sulphate | 0 46 | | | |
| Strontium sulphate | Trace | | | |
| Lithium sulphate | 0.02 | | | |
| Barium sulphate | 0.01 | | | |
| Calcium phosphate (acid) | 0.60 | | | |
| Sodium biborate | Trace | | | |
| Sodium nitrate | Trace | | | |
| Sodium chloride | 0.68 | 1.12 | | 562.89 |
| Calcium chloride | | | 52.16 | 82.61 |
| Potassium chloride | | | | 4.06 |
| Magnesium chloride | | | | 27.11 |
| Lithium chloride | | | | 2.37 |
| Sodium bromide | Trace | | | |
| Alumina | 0.14 | | | |
| Silica | 0.29 | | | 0.59 |
| Organic matter | Trace | Trace | | |
| Total | 61.32 | 123.44 | 119.92 | 781.29 |
| *Gases.* | *Cubic inches.* | *Cubic inches.* | *Cubic inches.* | *Cubic inches.* |
| Sulphureted hydrogen | | | 17.28 | |
| Carbonic acid | | | Trace | |

a F. F. Thomas, analyst. b J. R. Chilton, analyst. c Perkins, analyst. d C. F. Chandler, analyst (1876). e L. C. Beck, analyst (1842). f Peter Collier, analyst (1870). g With magnesium carbonate and iron oxide.

## Analyses of Mineral Springs in New York — (*Continued*).

| CONSTITUENTS. | Crystal Springs. | Deep Rock Mineral Spring. | Florida Spring. | Halleck's Spring. |
|---|---|---|---|---|
| *Solids.* | *Parts in 100.*a | *Grains per gallon.*b | *Grains per gallon.*c | *Grains per gallon.*d |
| Sodium bicarbonate | | | 22.14 | |
| Calcium carbonate | | 18.19 | | |
| Calcium bicarbonate | | | 8.32 | |
| Magnesium bicarbonate | | | 6.97 | |
| Sodium hyposulphate | | | 0.71 | |
| Calcium sulphate | | | | 40.00 |
| Potassium sulphate | | | 1.39 | |
| Sodium chloride | | 308.18 | 5.88 | 624.00 |
| Calcium chloride | | | | 104.00 |
| Potassium chloride | | 149.08 | | |
| Magnesium chloride | | 10.25 | | 32.00 |
| Iron sulphide | | | 0.18 | |
| Sodium sulphide | | | 2.01 | |
| Magnesia | .003 | | | |
| Lime | .008 | | | |
| Iron oxide | .001 | Trace. | | |
| Alumina | Trace. | | Trace. | |
| Silica | Trace. | 71.70 | 0.79 | |
| Soda | .001 | | | |
| Chlorine | .003 | | | |
| Iodine and phosphoric acid | Trace. | | | |
| Carbonic acid (combined) | .012 | | | |
| Sulphuric acid | .001 | Trace. | | |
| Loss | | 1.78 | | |
| Total | 0.029 | 559.18 | 48.39 | 800.00 |
| *Gases.* | *Cubic inches.* | *Cubic inches.* | *Cubic inches.* | *Cubic inches.* |
| Carbureted hydrogen | | | | Trace. |
| Sulphureted hydrogen | Trace. | | 3.765 | |
| Carbonic acid | Trace. | Undetermined. | 32.169 | Trace. |

| CONSTITUENTS. | Lebanon Thermal Spring. | Nunda Mineral Springs. | Chlorine Spring. | Excelsior Spring. | Lockport Mineral Spring. |
|---|---|---|---|---|---|
| *Solids.* | *Grains per gallon.*e | *Grains per gallon.*f | *Grains per gallon.*g | *Grains per gallon.*g | *Grains per gallon.*h |
| Sodium carbonate | 2.41 | | | | |
| Calcium carbonate | 4.04 | 104.10 | 22.38 | 15.24 | 9.27 |
| Iron carbonate | | 1.05 | | | |
| Calcium sulphate | | 184.41 | 38.63 | 36.45 | 5.72 |
| Potassium sulphate | 1.04 | | | | |
| Magnesium sulphate | 1.06 | 203.58 | | | |
| Sodium chloride | 0.96 | 6.82 | 646.42 | 538.53 | 111.42 |
| Sodium sulphide | 0.02 | | | | |
| Iron oxide | 0.94 | | Present. | | |
| Alumina | 0.45 | Trace. | | | 0 05 |
| Silica | 3.25 | 000.12 | 0.29 | 1.02 | 0.90 |
| Organic matter | 10.21 | | | | Trace. |
| Magnesium carbonate | | | | | 3.21 |
| Sodium sulphate | | | 26.28 | 13.16 | |
| Calcium chloride | | | | | 45.08 |
| Potassium chloride | | | | | 3.52 |
| Magnesium chloride | | | 17.86 | 17.69 | 11.04 |
| Magnesium bromide | | | | 0.15 | |
| Sodium bromide | | | | | 1.57 |
| Sodium iodide | | | | | 2.36 |
| Free carbonic acid | | | Present. | Present. | |
| Total | 24.38 | 500.08 | 751.86 | 668.24 | 194.14 |
| *Gases.* | *Cubic inches.* | *Cubic inches.* | *Cubic inches.* | *Cubic inches.* | *Cubic inches.* |
| Sulphureted hydrogen | | | | | 2.86 |
| Carbonic acid | 0.48 | | | | 5.79 |
| Oxygen | 2.00 | | | | |
| Nitrogen | 3.52 | | | | |

a J. Fowler, analyst (1880). b S. H. Douglas, analyst (1871). c C. F. Chandler, analyst (1870). d J. Noyes, analyst. e H. Dussance, analyst. f S. A. Lattimore, analyst (1878). g Charles A. Goessman, analyst (1868). h J. Hadley, analyst (1861).

## Analyses of Mineral Springs in New York — (*Continued*).

| CONSTITUENTS. | Sharon Springs. White Sulphur Spring. | Magnesia Spring. | Red Sulphur Spring. | Gardner Magnesia Spring. | Eye-Water Spring. |
|---|---|---|---|---|---|
| *Solids.* | *Grains per gallon.*a | *Grains per gallon.*a | *Grains per gallon.*b | *Grains per gallon.*c | *Grains per gallon.*a |
| Sodium bicarbonate | ..... | ..... | 0.49 | 0.54 | ..... |
| Calcium bicarbonate | ..... | ..... | 12.93 | 9.70 | ..... |
| Magnesium bicarbonate | 24.00 | 30.50 | 0.69 | 1.36 | 32.00 |
| Calcium sulphate | 85.40 | 76.00 | 96.64 | 93.50 | 77.50 |
| Magnesium sulphate | 34.00 | 22.70 | 18.96 | 19.68 | 7.50 |
| Sodium chloride | 2.70 | 3.00 | 0 33 | 1.23 | 2.50 |
| Magnesium chloride | | | 0.73 | 0.44 | |
| Calcium chloride | ..... | ..... | 0.07 | 0.16 | ..... |
| Calcium sulphide | 3.00 | 0.50 | 0.89 | 0.63 | ..... |
| Magnesium sulphide | | | | | |
| Silica | ..... | ..... | 0.45 | 0.40 | ..... |
| Total | 149.10 | 132.70 | 132.18 | 127.64 | 119.50 |
| *Gases.* | *Cubic inches.* | *Cubic inches.* | *Cubic inches.* | *Cubic inches.* | *Cubic inches.* |
| Sulphureted hydrogen | 20.50 | 3.30 | 10.50 | 6.00 | ..... |
| Carbonic acid | ..... | ..... | 4.58 | 2.22 | ..... |
| Atmospheric air | ..... | ..... | 4.00 | 3.00 | ..... |

| CONSTITUENTS. | Sharon Springs. Chalybeate Spring. | Gardner Magnesia Spring. | Red Sulphur Spring. | White Sulphur Spring. |
|---|---|---|---|---|
| *Solids.* | *Grains per gallon.*d | *Grains per gallon.*e | *Grains per gallon.*e | *Grains per gallon.*f |
| Sodium carbonate | ..... | 0.34 | 0.34 | ..... |
| Calcium carbonate | ..... | 6.73 | 8.97 | ..... |
| Magnesium carbonate | 8.96 | 0.80 | 0.41 | ..... |
| Sodium sulphate | 3.74 | ..... | ..... | ..... |
| Calcium sulphate | 63.80 | 93.59 | 96.64 | 55.84 |
| Potassium sulphate | Trace. | ..... | ..... | ..... |
| Magnesium sulphate | 8.15 | 19.68 | 18.96 | 21.29 |
| Iron protosulphate | 1 40 | ..... | ..... | ..... |
| Sodium chloride | ..... | 1.23 | 0.33 | 1.12 |
| Calcium chloride | ..... | 0.16 | 0.06 | ..... |
| Magnesium chloride | ..... | 0.43 | 0 73 | 1.20 |
| Sodium sulphide | ..... | ..... | ..... | g 1.12 |
| Calcium sulphide | ..... | 6.25 | 0.89 | ..... |
| Magnesium sulphide | ..... | | | |
| Silica | ..... | 0.40 | 0 45 | ..... |
| Organic matter | 28.48 | ..... | ..... | ..... |
| Total | 114.53 | 129.52 | 127.78 | 80.48 |
| *Gases.* | *Cubic inches.* | *Cubic inches.* | *Cubic inches.* | *Cubic inches.* |
| Sulphureted hydrogen | ..... | 6.00 | 10.48 | 8.00 |
| Carbonic acid | ..... | 2.21 | 4.56 | ..... |
| Atmospheric air | ..... | 3.00 | 4.00 | ..... |
| Total | ..... | 11.21 | 19 04 | 8.00 |

a Lawrence Reid, analyst (1845). b J. G. Pohle, analyst. c J. G. Pohle, analyst (1865). d Maische, analyst (1861). e Lawrence Reid, analyst. f J. R. Chilton, analyst. g With extractive matter.

## Analyses of Mineral Springs in New York — (*Continued*).

| CONSTITUENTS. | Oak Orchard Acid Springs. | | | | | |
|---|---|---|---|---|---|---|
| | Spring No. 1. | | Spring No. 2. | Oak Orchard Acid Water. | | |
| *Solids* | *Grains per gallon.* a | *Grains per gallon.* b | *Grains per gallon.* c | *Grains per gallon.* d | *Parts in* 1,000. e | *Parts in* 1,000. f |
| Sodium sulphate | 6.34 | ..... | ..... | 3.16 | 0.12 | 0.09 |
| Calcium sulphate | 74.89 | 39.60 | 12.41 | 13.72 | 1.11 | 1.12 |
| Potassium sulphate | 5.52 | ..... | ..... | 2.48 | 0.11 | 0.08 |
| Aluminium sulphate | 21.69 | 9.68 | ..... | 6.41 | 0.37 | 0.32 |
| Magnesium sulphate | 35.60 | 8.28 | 4.98 | 8.49 | 0.46 | 0.53 |
| Iron sulphate | ..... | ..... | 39.23 | ..... | 0.43 | 0.42 |
| Iron protosulphate | 28.62 | 14.32 | ..... | 32.22 | ..... | ..... |
| Sodium chloride | 2.44 | ..... | ..... | 1.43 | ..... | 0.04 |
| Silica | 4 59 | 1.04 | 1.84 | 3.33 | 0.06 | 0.07 |
| Chlorine | ..... | ..... | ..... | ..... | Trace. | ..... |
| Organic matter | ..... | 3.28 | 10.88 | 6.65 | Trace. | ..... |
| Sulphuric acid | 134.73 | 82.96 | 129.06 | 133.31 | 2.01 | 2.01 |
| Total | 314.42 | 159.16 | 198.40 | 211.20 | 4.67 | 4.68 |

| CONSTITUENTS. | Massena or St. Regis Springs. | Massena Sulphur Springs. | Richfield Springs. | | | | |
|---|---|---|---|---|---|---|---|
| | | | Name of spring unknown. | Sulphur Spring. | White Sulphur Spring. | Iron Spring. | Magnesia Spring. |
| *Solids.* | *Grains per gall.* g | *Grains per gall* h | *Grains per gall.* i | *Grains per gall.* j | *Grains per gall.* k | *Grains per gall.* l | *Grains per gall.* i |
| Calcium carbonate | ..... | 14.80 | 6.96 | ..... | ..... | ..... | ..... |
| Calcium bicarbonate | 4.85 | ..... | ..... | 24.47 | ..... | 11.71 | 16.11 |
| Magnesium carbonate | ..... | ..... | 11.84 | ..... | ..... | ..... | ..... |
| Magnesium bicarbonate | ..... | ..... | ..... | 6.01 | 31.74 | 12.52 | 3.97 |
| Iron bicarbonate | 0.49 | ..... | ..... | 0.24 | Trace. | 4.92 | 0.13 |
| Sodium hyposulphate | 4.21 | ..... | ..... | ..... | ..... | ..... | ..... |
| Sodium sulphate | 0.50 | ..... | ..... | 22.29 | ..... | 0.30 | 12.79 |
| Sodium hydrosulphate | ..... | ..... | ..... | ..... | 0.38 | ..... | ..... |
| Calcium sulphate | 60.03 | 68.40 | 20.00 | 67.39 | 112.34 | 5.00 | 38.63 |
| Potassium sulphate | ..... | ..... | ..... | ..... | 1.67 | ..... | ..... |
| Strontium sulphate | ..... | ..... | ..... | ..... | 0.01 | ..... | ..... |
| Magnesium sulphate | ..... | 10.88 | 30.00 | 32.82 | 5.15 | ..... | 18.81 |
| Barium sulphate | ..... | ..... | ..... | ..... | Trace. | ..... | ..... |
| Sodium phosphate | 1.32 | ..... | ..... | ..... | ..... | ..... | ..... |
| Calcium phosphate | ..... | ..... | ..... | ..... | Trace. | ..... | ..... |
| Sodium chloride | 76.79 | ..... | 1 1.49 | 21.73 | 0.52 | 0.43 | 10.20 |
| Calcium chloride | ..... | 10.64 | ..... | ..... | ..... | ..... | ..... |
| Potassium chloride | 0.51 | ..... | ..... | 8.23 | ..... | ..... | 4 51 |
| Magnesium chloride | 29.93 | ..... | ..... | ..... | ..... | ..... | ..... |
| Lithium chloride | ..... | ..... | ..... | ..... | 0.02 | ..... | ..... |
| Magnesium bromide | 0.67 | ..... | ..... | ..... | ..... | ..... | ..... |
| Sodium sulphide | 1.40 | ..... | ..... | ..... | 1.72 | ..... | ..... |
| Sodium and calcium sulphide | ..... | ..... | ..... | 6.22 | ..... | ..... | 6.06 |
| Calcium sulphide | ..... | ..... | ..... | ..... | 0.09 | ..... | ..... |
| Calcium & magnesium sulphides | ..... | ..... | 2.00 | ..... | ..... | ..... | ..... |
| Alumina | ..... | ..... | ..... | 0.10 | Trace. | ..... | ..... |
| Silica | ..... | ..... | ..... | 1.35 | 0.64 | 0.81 | 1.17 |
| Organic matter | m 11.18 | ..... | n 153.50 | ..... | ..... | ..... | ..... |
| Total | 191.88 | 104.72 | 225.79 | 190.85 | 154.28 | 35.69 | 106.38 |
| *Gases.* | *Cub. in.* | *Cub. in.* | *Cub. in.* | *Cub. in.* | *Cub. in.* | *Cub. in.* | *Cub. in.* |
| Sulphureted hydrogen | 5.307 | ..... | 24.24 | 3.6288 | 14.206 | ..... | 0.3160 |
| Carbonic acid | ..... | ..... | ..... | 2.9412 | ..... | 15.9236 | 2.2032 |

a Silliman & Norton, analysts. b J. R. Chilton, analyst. c E. Emmons, analyst. d Porter, analyst. e H. Erni, analyst (1850). f W. J. Craw, analyst (1850). g Ford F. Mayer, analyst. h L. C. Beck, analyst. i Lawrence Reid, analyst. j Theo. Deecke, analyst. k C. F. Chandler, analyst. l With magnesium chloride. m With silicate of soda. n Undetermined matter.

## Analyses of Mineral Springs in New York — (*Continued*).

| CONSTITUENTS. | Saratoga Springs. | | | | |
|---|---|---|---|---|---|
| | Champion Spouting Spring. | Columbian Springs. | Crystal Springs. | Congress Spring. | |
| *Solids.* | *Grains per gallon.*a | *Grains per gallon.*b | *Grains per gallon.*c | *Grains per gallon.*d | *Grains per gallon.*e |
| Sodium carbonate | ..... | ..... | ..... | ..... | 16.00 |
| Sodium bicarbonate | 17.62 | 15.40 | 10.06 | 8.98 | ..... |
| Calcium carbonate | ..... | 68.00 | ..... | 98.10 | 144 00 |
| Calcium bicarbonate | 227.07 | ..... | 101.88 | ..... | ..... |
| Magnesium bicarbonate | 193.91 | 46.71 | 75.16 | 95.79 | 32.00 |
| Strontium bicarbonate | 0.08 | ..... | Trace. | ..... | ..... |
| Lithium bicarbonate | 6.25 | ..... | 4.33 | ..... | ..... |
| Iron carbonate | ..... | 5.58 | ..... | 5.07 | ..... |
| Iron bicarbonate | 0.65 | ..... | 2.04 | ..... | ..... |
| Barium bicarbonate | 2.08 | ..... | 0.73 | ..... | ..... |
| Potassium sulphate | 0.25 | ..... | 2.16 | ..... | ..... |
| Sodium phosphate | 0.01 | ..... | Trace. | ..... | ..... |
| Sodium biborate | Trace. | ..... | Trace. | ..... | ..... |
| Sodium chloride | 702.24 | 267.00 | 328.47 | 385.00 | 434.40 |
| Potassium chloride | 40.45 | ..... | 8.33 | ..... | ..... |
| Potassium bromide | ..... | Trace. | ..... | Trace. | ..... |
| Sodium bromide | 3.58 | ..... | 0.41 | ..... | ..... |
| Calcium fluoride | Trace. | ..... | Trace. | ..... | ..... |
| Sodium iodide | 0.23 | 2.56 | 0.06 | 3.50 | ..... |
| Alumina | 0.46 | ..... | 0.31 | ..... | ..... |
| Silica | 0.70 | 2.05 | 3.21 | 1.50 | f Trace. |
| Organic matter | Trace. | ..... | Trace. | ..... | ..... |
| Total | 1,195.58 | 407.30 | 527.15 | 597.94 | 626.40 |
| *Gases.* | | | | | |
| Atmospheric air | ..... | 4.50 | ..... | 7.00 | ..... |
| Azote | ..... | ..... | ..... | ..... | 7.20 |
| Carbonic acid | 465.46 | 272.06 | 317.45 | 311.00 | 312.80 |

| CONSTITUENTS. | Saratoga Springs. | | | | |
|---|---|---|---|---|---|
| | Congress Spring. | | | Empire Spring. | |
| *Solids.* | *Grains per gallon.*a | *Grains per gallon.*g | *Grains per gallon.*h | *Grains per gallon.*c | *Grains per gallon.*i |
| Sodium carbonate | ..... | 0.56 | 7.20 | ..... | ..... |
| Sodium bicarbonate | 10.77 | ..... | ..... | 9.02 | 20.85 |
| Calcium carbonate | ..... | 116.00 | 86.14 | ..... | ..... |
| Calcium bicarbonate | 143.40 | ..... | ..... | 109.66 | 141.82 |
| Magnesium carbonate | ..... | 56.80 | 78.62 | ..... | ..... |
| Magnesium bicarbonate | 121.76 | ..... | ..... | 42.96 | 41.98 |
| Strontium bicarbonate | Trace. | ..... | ..... | Trace. | ..... |
| Lithium bicarbonate | 4.76 | ..... | ..... | 2.08 | ..... |
| Iron carbonate | ..... | ..... | 0.84 | ..... | ..... |
| Iron bicarbonate | 0.34 | ..... | ..... | 0.79 | Trace. |
| Barium bicarbonate | 0.93 | ..... | ..... | 0.07 | ..... |
| Sodium sulphate | ..... | ..... | 0.65 | ..... | ..... |
| Potassium sulphate | 0.89 | ..... | ..... | 2.77 | ..... |
| Sodium phosphate | 0.02 | ..... | ..... | 0.02 | ..... |
| Sodium biborate | Trace. | ..... | ..... | Trace. | ..... |
| Sodium chloride | 400.44 | 385.44 | 363 83 | 506.63 | 269.70 |
| Potassium chloride | 8.05 | ..... | ..... | 4.29 | ..... |
| Potassium bromide | ..... | Trace. | j 5.92 | ..... | ..... |
| Sodium bromide | 8.56 | ..... | ..... | 0.27 | ..... |
| Calcium fluoride | Trace. | ..... | ..... | Trace. | ..... |
| Sodium iodide | 0.14 | 4.02 | ..... | Trace. | k 12.00 |
| Iron oxide | ..... | 0.64 | ..... | ..... | ..... |
| Alumina | Trace. | ..... | 0.32 | 0.42 | ..... |
| Silica | 0.84 | ..... | 0.47 | 1.46 | ..... |
| Organic matter | ..... | ..... | ..... | Trace. | ..... |
| Total | 700.90 | 563.46 | 543.99 | 680.44 | 496.35 |
| *Gases.* | | | | | |
| Atmospheric air | ..... | ..... | 5.41 | ..... | ..... |
| Carbonic acid | 392.30 | ..... | 284.65 | 344.67 | ..... |

a C. F. Chandler, analyst (1871). b John H. Steele, analyst (prior to 1838). c C. F. Chandler, analyst. d John H. Steele, analyst. e J. D. Dana, analyst. f With iron. g Davy and Faraday, analysts, London. h J. R. Chilton, analyst (1843). i E. Emmons, analyst. j With sodium iodide. k Or iodine.

## Analyses of Mineral Springs in New York — (*Continued*).

| CONSTITUENTS. | Saratoga Springs. | | | | |
|---|---|---|---|---|---|
| | Eureka Spring. | Excelsior Spring. | Flat Rock Spring. | | Geyser Spouting Spring. |
| *Solids* | *Grains per gallon.*a | *Grains per gallon.*b | *Grains per gallon.*c | *Grains per gallon* d | *Grains per gallon.*e |
| Sodium bicarbonate | 8.75 | 15.00 | 20.79 | 9.10 | 71.23 |
| Calcium carbonate | ..... | ..... | 60.57 | ..... | ..... |
| Calcium bicarbonate | 41.32 | 77.00 | ..... | 93.63 | 168.39 |
| Magnesium bicarbonate | 29.34 | 32.33 | 42.70 | 29.47 | 149.34 |
| Strontium bicarbonate | ..... | ..... | ..... | 0.61 | 0.43 |
| Lithium bicarbonate | ..... | ..... | ..... | 3.23 | 9.00 |
| Iron carbonate | ..... | ..... | 5.39 | ..... | ..... |
| Iron bicarbonate | 3.00 | 3.22 | ..... | 0 09 | 0.98 |
| Barium bicarbonate | ..... | ..... | ..... | 0.10 | 2.01 |
| Sodium sulphate | ..... | 1.32 | ..... | ..... | ..... |
| Potassium sulphate | ..... | ..... | ..... | 0.48 | 0.32 |
| Strontium sulphate | ..... | Trace. | ..... | ..... | ..... |
| Magnesium sulphate | 2.15 | ..... | ..... | ..... | ..... |
| Sodium phosphate | ..... | ..... | ..... | 0.04 | Trace. |
| Sodium biborate | ..... | ..... | ..... | Trace. | Trace. |
| Sodium chloride | 166.81 | 370.64 | 148 87 | 108.85 | 562.08 |
| Potassium chloride | ..... | ..... | ..... | 7.99 | 24.64 |
| Magnesium chloride | ..... | ..... | ..... | 10.83 | ..... |
| Potassium bromide | 1.57 | Trace. | Trace. | ..... | ..... |
| Sodium bromide | ..... | ..... | ..... | 0.32 | 2.21 |
| Calcium fluoride | ..... | ..... | ..... | ..... | Trace. |
| Sodium iodide | 4.67 | 4.24 | 1.33 | 0 01 | 0.25 |
| Alumina | 0.23 | ..... | Trace. | 0.04 | Trace. |
| Silica | 0.53 | ..... | Trace. | 1.34 | 0.66 |
| Organic matter | ..... | ..... | ..... | Trace. | Trace. |
| Sodium silicate | ..... | 4.00 | ..... | ..... | ..... |
| Potassium silicate | ..... | 7.00 | ..... | ..... | ..... |
| Total | 258.37 | 514.75 | 279.65 | 270.53 | 991.54 |
| *Gases.* | | | | | |
| Atmospheric air | ..... | ..... | 6.50 | ..... | ..... |
| Carbonic acid | 239.00 | 250.00 | 287.50 | ..... | 454.08 |

| CONSTITUENTS. | Saratoga Springs. | | | | |
|---|---|---|---|---|---|
| | Hamilton Spring. | | Hathorn Spring. | High Rock Springs. | |
| *Solids.* | *Grains per gallon.*f | *Grains per gallon.*a | *Grains per gallon.*g | *Grains per gallon.*g | *Grains per gallon.*f |
| Sodium carbonate | ..... | 34.25 | ..... | ..... | ..... |
| Sodium bicarbonate | 27.04 | ..... | 4.29 | 84.89 | 17.54 |
| Calcium carbonate | 92.40 | 97.99 | ..... | ..... | 69.29 |
| Calcium bicarbonate | ..... | ..... | 170.65 | 131.74 | ..... |
| Magnesium carbonate | ..... | 39.06 | ..... | ..... | ..... |
| Magnesium bicarbonate | 35.20 | ..... | 176.46 | 54.92 | 61.59 |
| Strontium bicarbonate | ..... | ..... | Trace. | Trace. | ..... |
| Lithium bicarbonate | ..... | ..... | 11.45 | ..... | ..... |
| Iron carbonate | ..... | 4.62 | ..... | ..... | 5.58 |
| Iron bicarbonate | 5.39 | ..... | 1.13 | 1.48 | ..... |
| Barium bicarbonate | ..... | ..... | 1.74 | Trace. | ..... |
| Potassium sulphate | ..... | ..... | ..... | 1.61 | ..... |
| Sodium phosphate | ..... | ..... | Trace. | ..... | ..... |
| Calcium phosphate | ..... | ..... | ..... | Trace. | ..... |
| Sodium biborate | ..... | ..... | Trac . | ..... | ..... |
| Sodium chloride | 297.30 | 298.66 | 509.97 | 390.13 | 189.10 |
| Potassium chloride | ..... | ..... | 9.60 | 8.50 | ..... |
| Potassium bromide | Trace. | ..... | ..... | ..... | Trace. |
| Sodium bromide | ..... | ..... | 1.53 | 0.73 | ..... |
| Calcium fluoride | ..... | ..... | Trace. | Trace. | ..... |
| Sodium iodide | 3.00 | 3.59 | 0.19 | 0.08 | 2.50 |
| Alumina | ..... | ..... | 0.13 | 1.22 | Trace. |
| Silica | ..... | 1.00 | 1.26 | 2.26 | Trace. |
| Organic matter | ..... | ..... | Trace. | Trace. | ..... |
| Total | 460.33 | 479.17 | 888.40 | 627.56 | 345.60 |
| *Gases.* | | | | | |
| Atmospheric air | 4.00 | ..... | ..... | ..... | 5.00 |
| Carbonic acid | 316.00 | 320.00 | 375.75 | 409.46 | 304.00 |

a Allen, analyst. b Allen, analyst (1879). c John H. Steele, analyst. d C. F. Chandler, analyst (1885). e C. F. Chandler, analyst (1870). f John H. Steele, analyst (prior to 1888). g C. F. Chandler, analyst.

## ANALYSES OF MINERAL SPRINGS IN NEW YORK — (*Continued*).

| CONSTITUENTS. | SARATOGA SPRINGS. | | | |
|---|---|---|---|---|
| | Kisssingen or Triton Spring. | Pavilion Spring. | | Putnam Spring. |
| *Solids.* | *Grains per gallon.*a | *Grains per gallon.*b | *Grains per gallon.*c | *Grains per gallon.*c |
| Sodium carbonate | ..... | ..... | 4.92 | ..... |
| Sodium bicarbonate | 67.62 | 3.76 | ..... | 14.32 |
| Calcium carbonate | ..... | ..... | 52.84 | ..... |
| Calcium bicarbonate | 140.26 | 120.17 | ..... | 68.80 |
| Magnesium carbonate | ..... | ..... | 56.92 | ..... |
| Magnesium bicarbonate | 70.47 | 76.27 | ..... | 51.60 |
| Strontium bicarbonate | Trace. | Trace. | ..... | ..... |
| Lithium bicarbonate | 5.13 | 9.49 | ..... | ..... |
| Iron carbonate | ..... | ..... | 3.51 | ..... |
| Iron bicarbonate | 1.56 | 2.57 | ..... | 7.00 |
| Barium bicarbonate | 0.99 | 0.88 | ..... | ..... |
| Sodium sulphate | ..... | ..... | 1.48 | 1.68 |
| Potassium sulphate | Trace. | 2.03 | ..... | ..... |
| Sodium phosphate | ..... | Trace. | ..... | 0.21 |
| Calcium phosphate | ..... | ..... | 0.19 | ..... |
| Sodium biborate | ..... | Trace. | ..... | ..... |
| Sodium chloride | 338.50 | 459.90 | 187.68 | 214.00 |
| Potassium chloride | 16.98 | 7.66 | ..... | ..... |
| Potassium bromide | ..... | ..... | d2.59 | Trace. |
| Sodium bromide | 1.80 | 0.99 | ..... | ..... |
| Calcium fluoride | Trace. | Trace. | ..... | ..... |
| Sodium iodide | 0.04 | 0 07 | ..... | 2.00 |
| Alumina | Trace. | 0.33 | 0.42 | 0.56 |
| Silica | 1.28 | 3.16 | 1.16 | 0.84 |
| Organic matter | ..... | Trace. | ..... | ..... |
| Total | 644.63 | 687.28 | 311.71 | 361.01 |
| *Gases.* | | | | |
| Carbonic acid | 361.50 | 332.46 | 359.50 | 326.40 |
| Atmospheric air | ..... | ..... | 5.30 | 6.40 |

| CONSTITUENTS. | SARATOGA SPRINGS. | | | |
|---|---|---|---|---|
| | New Putnam Spring. | Red Spring. | Saratoga A or Alum Spring. | Seltzer Spring. |
| *Solids.* | *Grains per gallon* b | *Grains per gallon* c | *Grains per gallon.*f | *Grains per gallon.*g |
| Sodium bicarbonate | 8.08 | 15.33 | 6.75 | 29.43 |
| Calcium bicarbonate | 157.56 | 101.26 | 56.85 | 89.87 |
| Magnesium bicarbonate | 173.61 | 42.41 | 20.48 | 40.34 |
| Strontium bicarbonate | 0.11 | Trace. | ..... | Trace. |
| Lithium bicarbonate | 9.83 | 0.94 | 1.72 | 0.90 |
| Iron bicarbonate | 0.45 | ..... | 1.72 | 1.70 |
| Barium bicarbonate | 0.38 | ..... | ..... | Trace. |
| Sodium sulphate | ..... | ..... | 2.50 | ..... |
| Calcium sulphate | ..... | ..... | 0.45 | ..... |
| Potassium sulphate | 2.26 | ..... | 0.37 | 0.56 |
| Magnesium sulphate | ..... | ..... | 0.29 | ..... |
| Sodium phosphate | Trace. | ..... | ..... | Trace. |
| Calcium phosphate | ..... | ..... | ..... | Trace. |
| Sodium biborate | Trace. | ..... | ..... | Trace. |
| Sodium chloride | 268.04 | 83.53 | 565.30 | 134.29 |
| Calcium chloride | ..... | ..... | Trace. | ..... |
| Potassium chloride | 14.87 | 6.86 | 0.36 | 1.34 |
| Magnesium chloride | ..... | ..... | Trace. | ..... |
| Sodium bromide | 1.52 | ..... | ..... | 0.63 |
| Calcium fluoride | Trace. | ..... | ..... | Trace. |
| Sodium iodide | Trace. | ..... | ..... | 0.03 |
| Boracic acid | ..... | ..... | ..... | Trace. |
| Iron oxide | ..... | b2.10 | ..... | ..... |
| Alumina | 0.22 | | 0.38 | 0.37 |
| Silica | 3.00 | 3.25 | 1.46 | 2.56 |
| Organic matter | Trace. | ..... | Trace. | Trace. |
| Total | 640.03 | 255.68 | 658.63 | 302.02 |
| *Gases.* | | | | |
| Carbonic acid | ..... | ..... | 212.00 | 324.08 |

a Sharples, analyst (1872). b C. F. Chandler, analyst (1882). c J. R. Chilton, analyst (1840). d With sodium iodide. e Appleton, analyst. f J. G. Phole, analyst. g C. F. Chandler, analyst (1869). h With traces of phosphates.

## Analyses of Mineral Springs in New York — (*Continued*).

| CONSTITUENTS. | Saratoga Springs. | | | |
|---|---|---|---|---|
| | Star Spring. | Union Spring. | | United States Spring. |
| *Solids.* | *Grains per gallon.* a | *Grains per gallon.* b | *Grains per gallon.* c | *Grains per gallon.* a |
| Sodium carbonate | ..... | 12.80 | ..... | ..... |
| Sodium bicarbonate | 12.66 | ..... | 17.01 | 4.67 |
| Calcium carbonate | ..... | 41.60 | ..... | ..... |
| Calcium bicarbonate | 124.46 | ..... | 96.70 | 93.12 |
| Magnesium carbonate | ..... | 84.27 | ..... | ..... |
| Magnesium bicarbonate | 61.91 | ..... | 109.69 | 72.88 |
| Strontium bicarbonate | Trace. | ..... | Trace. | 0.02 |
| Lithium bicarbonate | 1.50 | ..... | 2.61 | 4.85 |
| Iron carbonate | ..... | 5.45 | ..... | ..... |
| Iron bicarbonate | 1.21 | ..... | 0.27 | 0.71 |
| Barium bicarbonate | 0.10 | ..... | 1.70 | 0.91 |
| Potassium sulphate | 5.40 | ..... | 1.82 | ..... |
| Sodium phosphate | Trace. | ..... | 0.03 | 0.02 |
| Sodium biborate | Trace. | ..... | Trace. | Trace. |
| Sodium chloride | 398.36 | 243.62 | 458.30 | 141.87 |
| Potassium chloride | 9.70 | ..... | 8.73 | 8.62 |
| Potassium bromide | ..... | Trace. | ..... | ..... |
| Sodium bromide | 0.57 | ..... | 1.30 | 0.84 |
| Calcium fluoride | Trace. | ..... | Trace. | Trace. |
| Sodium iodide | 0.13 | 3.60 | 0.04 | 0.05 |
| Alumina | Trace. | 1.57 | 0.32 | 0.09 |
| Silica | 1.28 | | 2.65 | 3.19 |
| Organic matter | Trace. | ..... | Trace. | Trace. |
| Total | 617.37 | 392.91 | 696.17 | 331.84 |
| *Gases.* | | | | |
| Carbonic acid | 407.65 | 344.16 | 384.97 | 245.73 |
| Atmospheric air | ..... | 4.62 | ..... | ..... |

| CONSTITUENTS. | Saratoga Springs. | | | |
|---|---|---|---|---|
| | Vichy Spring. | Walton or Iodine Spring (Star Spring). | Washington Spring. | |
| *Solids.* | *Grains per gallon.* a | *Grains per gallon.* d | *Grains per gallon.* e | *Grains per gallon.* f |
| Sodium carbonate | ..... | 2.00 | ..... | ..... |
| Sodium bicarbonate | 82.87 | ..... | 8.48 | 16.50 |
| Calcium carbonate | ..... | 26.00 | ..... | 99.60 |
| Calcium bicarbonate | 95.52 | ..... | 84.10 | ..... |
| Magnesium carbonate | ..... | 75.00 | ..... | ..... |
| Magnesium bicarbonate | 41.50 | ..... | 65.27 | 40.92 |
| Strontium bicarbonate | Trace. | ..... | ..... | ..... |
| Lithium bicarbonate | 1.76 | ..... | ..... | ..... |
| Iron carbonate | ..... | 1.00 | ..... | 3.25 |
| Iron bicarbonate | 0.05 | ..... | 3.80 | ..... |
| Barium bicarbonate | 0.59 | ..... | ..... | ..... |
| Potassium sulphate | Trace. | ..... | ..... | ..... |
| Magnesium sulphate | ..... | ..... | 0.05 | ..... |
| Sodium phosphate | Trace. | ..... | ..... | ..... |
| Sodium biborate | Trace. | ..... | ..... | ..... |
| Sodium chloride | 128.69 | 187.00 | 182.73 | 281.50 |
| Calcium chloride | ..... | ..... | 0.20 | ..... |
| Potassium chloride | 14.11 | ..... | ..... | ..... |
| Magnesium chloride | ..... | ..... | 0 68 | ..... |
| Potassium bromide | ..... | ..... | 0.47 | ..... |
| Sodium bromide | 0.99 | ..... | ..... | ..... |
| Calcium fluoride | Trace. | ..... | ..... | ..... |
| Sodium iodide | Trace. | 3.50 | 2.24 | 2.75 |
| Alumina | 0.48 | ..... | Trace. | ..... |
| Silica | 0.76 | ..... | 1.50 | 1.50 |
| Organic matter | Trace. | ..... | ..... | ..... |
| Total | 367.32 | 294.50 | 350.22 | 439.01 |
| *Gases.* | | | | |
| Carbonic acid | 383.07 | 326.00 | 363.77 | 262.50 |
| Atmospheric air | ..... | 4.00 | ..... | 6.80 |

a C. F. Chandler, analyst. b J. R. Chilton, analyst (1841). c C. F. Chandler, analyst (1873).
d E. Emmons, analyst (1839). e J. R. Chilton, analyst. f John H. Steele, analyst (prior to 1898).

# Minerals Not Commercially Important.

In addition to the minerals which have already been mentioned there are many deposits in New York which are not at present of commercial importance. These may be roughly classified as metallic minerals and non-metallic minerals. In the first class are iron pyrites, arsenopyrite, chromite, chalcopyrite, cuprite, galenite, cerusite, sphalerite, wad or bog manganese, millerite and molybdenite. The galenite and pyrites have respectively yielded small quantities of silver and gold at certain places, but at no locality in New York have enough of the precious metals been found at any time to pay for the expense of extracting them. From time to time capital is invested for the purpose of gold or silver mining in New York, but always without practical results. The experience of 50 years has shown that neither in New York nor in England have either of the metals been found in paying quantities.

The following† is a list of the principal localities at which these various metallic minerals are to be found:

### Iron, Sulphur, Arsenic.

*Pyrite, iron pyrites, bisulphide of iron.*—Anthony's nose, Montgomery, Westchester county, mine formerly worked; Phillip ore bed, Phillipstown, Patterson, southeast of Carmel and near Ludington mills, in Putnam county; with galena at Wurtsboro lead mine, Sullivan county; Flat creek, Montgomery county; near Canton, St. Lawrence county, in extensive beds; Duane, Franklin county, large bed; Martinsburg, Lewis county; Eighteen-mile creek, Erie county, and many other localities, sparingly in rocks.

*Arsenopyrite, mispickel.*— Near Edenville, Orange county, with arsenical iron and orpiment, in a vein in white limestone; near Pine pond in Kent, and near Boyd's Corner, Putnam county. These localities have been opened, but not worked for arsenic.

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† From an article by I. C. Smock in Mineral Resources of the U. S., Washington, 1882.

*Chromite, chrome iron ore.*— In serpentine, Phillipstown, Putnam county; Wilks' mine, Monroe, Orange county.

## Copper.

*Chalcopyrite, copper pyrites; sulphide of iron and copper.*— Ancram lead mine, Columbia county; Bockee mine, Columbia county; near Edenville, Orange county; with arsenopyrite; near Wurtsboro, Sullivan county, with galena in considerable abundance; Ellenville and Red Bridge lead mines, Ulster county; near Rossie, and also near Canton, in St. Lawrence county, once worked. Many additional occurrences are reported where it is in small quantity.

*Cuprite, red oxide of copper.*— Near Ladentown, Rockland county, in thin seams, in traprock.

## Lead.

*Galenite, galena; sulphide of lead.*— Otisville, Orange county; Ellenville and Red Bridge, Ulster county; with copper pyrites and blende in a gangue of quartz in Oneida conglomerate, mines no longer worked; Wurtsboro, Sullivan county; near Sing Sing, in Westchester county; northeast township, Dutchess county; Ancram, Columbia county; strings of galena, blende and pyrites in limestone; White creek, Washington county; Martinsburg, Lewis county; Spraker's basin, Montgomery county; Rossie and vicinity, St. Lawrence county; *mines largely worked years ago;* ore occurs in vein with blende, pyrites and copper pyrites. These mines have all been idle for several years.

*Cerusite, carbonate of lead.*— Rossie, Robinson, Ross, and other lead mines, in St. Lawrence county; Martinsburg, Lewis county; near Sing Sing, on Hudson, associated with galena, in small quantity.

## Zinc.

*Sphalerite, zinc blende; sulphide of zinc.*— Associated with galena at lead mines in Sullivan, Ulster and Orange counties; Ancram, Columbia county; Flat creek, Montgomery county; Salisbury, Herkimer county; Martinsburg, Lewisburg, Lewis county; Cooper's Falls, Mineral Point, and in Fowler, St. Lawrence county.

## Manganese.

*Wad, earthy manganese, bog manganese.*— In town of Austerlitz, Columbia county, are several localities; also in Hillsdale and Canaan, same county; smaller deposits near Houseville, Lewis county, and southeast of Warwick, Orange county.

## Nickel.

*Millerite, sulphide of nickel.*— Sterling iron mine, Antwerp, Jefferson county, famous for crystalline forms.

## Molybdenum.

*Molybdenite; sulphide of molybdenum.*— West Point and near Warwick, Orange county; Phillip mine, Putnam county; Clinton county, but sparingly, in granite rocks.

## Non-Metallic Minerals.

Under the heading of non-metallic minerals which do not occur in New York in sufficient quantity to be of economic importance may be enumerated apatite, barite, calcite, muscovite, biotite, serpentine, asbestus and magnesite. The principal localities for these minerals are given herewith:

*Calcite, calcareous tufa, travertine; carbonate of lime.*—Vicinity Schoharie Courthouse, Schoharie county; Sharon Springs, a large deposit; Howe's Cave, Schoharie county; near Catskill, Greene county; head of Otsquaga creek, Stark, Herkimer county; Saratoga Springs; near Syracuse and in Onondaga valley, Onondaga county; between Camillus and Canton, same county; near Arkport, Steuben county; near Ellicott's mills, Erie county, and many lesser deposits.

*Fluorite, fluorspar; fluoride of lime.*— Muscalonge lake, Alexandria, Jefferson county, very fine crystals; Lowville, Lewis county; Niagara, county, at Lockport; Auburn, Cayuga county; Rossie and Mineral Point, St. Lawrence county.

*Apatite, phosphate of lime.*— Hammond, St. Lawrence county, crystalline, with calcite, zinc ore and feldspar; near Gouverneur, St. Lawrence county, crystals in calcite, Vrooman lake, Jefferson county; Greenfield, Saratoga county; near Hammondsville, Essex county; with magnetite in some of iron ores near Port Henry; other localities of occurrence.

*Barite, barytes, heavy spar; sulphate of baryta.*— Ancram, Columbia county; near Schoharie Courthouse, with strontianite, in Water-lime group; Carlisle, Schoharie county; near Little Falls and Fairfield, Herkimer county; near Syracuse, Onondaga county; Pillar Point, Jefferson county, in large veins; Hammond and De Kalb, St. Lawrence county.

*Magnesite, carbonate of magnesia.*— Near Rye, Westchester county; Warwick, Orange county; New Rochelle, Westchester county; Stony Point, Rockland county; Serpentine hills, Staten Island; everywhere in thin seams and strings.

*Muscovite, mica.*— As a rock constituent, common In large plates near Warwick and at Greenwood at Mount Basha pond, in Orange county; Pleasantville, Westchester county, once opened and mined; Henderson, Jefferson county; Potsdam and Edwards, in St. Lawrence county.

*Serpentine.*— Staten Island, near New Rochelle and near Rye, Westchester county; Phillipstown, Putnam county; near Amity, Orange county, verd antique; Johnsburg and Warrensburg, Warren county; Shelving rock, Lake George, Washington county; Gouverneur, Fowler, Edwards and Pitcairn townships, in St. Lawrence county; other localities of occurrence in small quantity.

## Coal and Lignite.

Coal and lignite, while they occur in New York, can never be found in commercial quantities. The coal measures of Pennsylvania are not found north of the boundary line between Pennsylvania and New York, and what coal has been discovered in the latter State is in older formations which do not contain this valuable mineral in commercial quantities. Many thousands of dollars have been spent in fruitless efforts to obtain coal in New York, but year after year persons appear in the field who seem anxious to pay for their own experience. It can not be too strongly urged upon the attention of the people of the State that it is absolutely useless to seek for coal in New York.

*Coal.*—Woodstock, Ulster county, thin vein in Catskills, worked out; in the seams interstratified with shales, in Chautauqua, Erie, Livingston and Seneca counties.

*Lignite, brown coal.*— Near Rossville, Staten Island, thin seam in clay; also in Suffolk county in clays.

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ECONOMIC AND GEOLOGIC MAP
OF THE

# STATE OF NEW YORK

SHOWING THE

## LOCATION OF ITS MINERAL DEPOSITS

BY

FREDERICK J. H. MERRILL
Director New York State Museum

Prepared to accompany the report on the
Mineral Exhibit of New York at the
WORLD'S COLUMBIAN EXPOSITION
By authority of
The Board of General Managers
and
*THE REGENTS OF THE UNIVERSITY*
1895

Scale of Miles
5 0 5 10 15 20 25 30 35

SECOND EDITION

The geology of this map is based on the Agricultural and Geological map of 1844, with additions and corrections from the following sources.

PUBLISHED MAPS AND PAPERS.

| | |
|---|---|
| BRITTON, N. L., | *Richmond county.* |
| CLARKE, J. M., | *Ontario county.* |
| CUSHING, H. P., | *Clinton county.* |
| DALE, T. N., | *Columbia and Rensselaer counties.* |
| DARTON, N. H., | *Ulster county.* |
| GEDDES, GEORGE, | *Onondaga county.* |
| HALL, C. E., | *Essex county.* |
| HALL, JAMES, | *4th Geol. Dist. and Mohawk valley.* |
| KEMP, J. F., | *Essex county.* |
| SMOCK, J. C., | *Rockland and Orange counties.* |
| SMYTH, C. H., Jr., | *Jefferson and Lewis counties.* |
| WALCOTT, C. D., | *Washington, Rensselaer and Columbia counties.* |
| WHITE, T. G., | *Essex county.* |
| WRIGHT, B. H., | *Yates county.* |

UNPUBLISHED MATERIAL.

| | |
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| DWIGHT, W. B., | *Dutchess and Orange counties.* |
| FAIRCHILD, H. L., | *Monroe county.* |
| MERRILL, F. J. H., | *Kings, Suffolk, Westchester, Dutchess, Putnam and Warren counties.* |
| PROSSER, C. S., | *Ulster, Otsego, Chenango, Cortland, Cayuga, Tompkins, etc.* |
| RIES, HEINRICH, | *Westchester county.* |
| SCHNEIDER, F. F., | *Onondaga county.* |
| SMYTH, C. H., Jr., | *Oneida county.* |

LAKE ONTARIO

247 feet above mean tide at New York

LAKE ERIE

573 feet above mean tide at New York

LEGEND

| | | |
|---|---|---|
| Quaternary | | Till, Gravel etc. |
| Tertiary | | Sand and Clay |
| Cretaceous | | Clays and Sands |
| Triassic | Plutonic | Diabase |
| Triassic | | Sandstone |
| Carboniferous | Olean | Conglomerate |
| Devonian | Catskill | Sandst. and Conrd |
| | Chemung | Sandst. and Shale |
| | Portage | Sandst. and Shale |
| | Hamilton | Shale and Sandst. |
| Upper Silurian | Upper Helderberg | Limestones |
| | Lower Helderberg | Limestones |
| | Salina | Shales and Limest. |
| | Niagara | Shales and Limest |
| | Clinton | Sandst. and Limest. |
| | Medina | Sandstone |
| Lower Silurian | Hudson River | Shale and Schist |
| | Plutonic | Granite, Diorite etc. |
| | Calciferous-Trenton | Limestone |
| | Potsdam | Sandstone |
| Precambrian | Lower Cambrian | Slate and Limestone |
| | Unclassified | Granites, Gneisses and Limestones |
| | Plutonic | Norite |
| | | Granite |

Note. *The rocks mapped as Calciferous-Trenton and Hudson River in New York, Westchester, Putnam and Southeastern Dutchess Counties are highly metamorphosed and crystalline limestones and schists. The Potsdam horizon in Dutchess Co. is represented by limestone.*

LEGEND
OF
ECONOMIC MINERALS

- Salt wells, mines and brine springs
- Gypsum quarries
- Gas wells
- Gas fields
- Oil fields
- Clay deposits and factories
- Clay deposits only
- Refractory Clays
- Stone quarries
- Hydraulic limestone
- Mines of magnetic iron ore
- Mines of brown hematite and spathic ore
- Mines of specular and fossil ore
- Garnet
- Graphite
- Mineral Paint
- Talc
- Glass sand
- Mineral Springs

ATLANTIC OCEAN

JULIUS BIEN & CO. LITH. N.Y.

# GEOLOGICAL MAP

OF A PART OF

# SOUTHEASTERN NEW YORK

SHOWING THE DISTRIBUTION OF ROCKS USED AS BUILDING STONES.

BY

FREDERICK J. H. MERRILL

Director, New York State Museum.

ALBANY, N. Y.

1895.

SCALE OF MILES. 5 4 3 2 1 0 5 10

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## LEGEND.

GEOLOGICAL AGE AND CHARACTER.

| IGNEOUS | | | | | TRIASSIC | LOWER SILURIAN | | PRECAMBRIAN |
|---|---|---|---|---|---|---|---|---|
| TRIASSIC DIABASE | ALTERED BASIC ROCKS | CORTLAND SERIES | HARRISON DIORITE | YONKERS GNEISS | | HUDSON RIVER | CALCIFEROUS-TRENTON | |
| SCIENTIFIC NAME: DIABASE | SERPENTINE | DIORITE AND NORITE | GRANITE-DIORITE | GNEISSOID GRANITE | SANDSTONE | MICA SCHIST | DOLOMITE | GNEISS AND GRANITE |
| COMMERCIAL NAME: TRAP | | TRAP | GRANITE | GRANITE | SANDSTONE | | MARBLE | GRANITE |

## New York State Museum

### REPORTS AND BULLETINS

**Museum reports.** New York state museum. Annual report, 1847— date. pl. O. Albany 1848 to date.

Average 250 pages a year. *Price for all now in print, 50 cents a volume in paper; 75 cents in cloth. 1892-date, 75 cents, cloth.*

**Economic map.** Merrill, F: J. H. Economic map of the state of New York. 59×67 cm. 1894. *Price, unmounted, 25 cents, backed on muslin 75 cents, mounted on rollers 75 cents.*

Scale 14 miles to one inch.

**Museum bulletins.** University of the State of New York, Bulletin of the New York state museum. v. 1–2, O. Albany 1887— date. *Price to advance subscribers, 50 cents a volume.*

**Volume 1.** 6 *nos.*

Bulletins of this volume are paged independently.

1 Marshall, W: B. Preliminary list of New York unionidæ. 19p. March 1892. *Price 5 cents.*

2 Peck, C: H. Contributions to the botany of the state of New York. 66p. 2 pl. May 1887. *Price 25 cents.*

3 Smock, J: C. Building stone in the state of New York. 152p. March 1888. *Out of print.*

4 Nason, F. L. Some New York minerals and their localities. 19p. 1 pl. Aug. 1888. *Price 5 cents.*

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6 Lintner, J. A. Cut-worms. 36p. il Nov. 1888. *Price 10 cents.*

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